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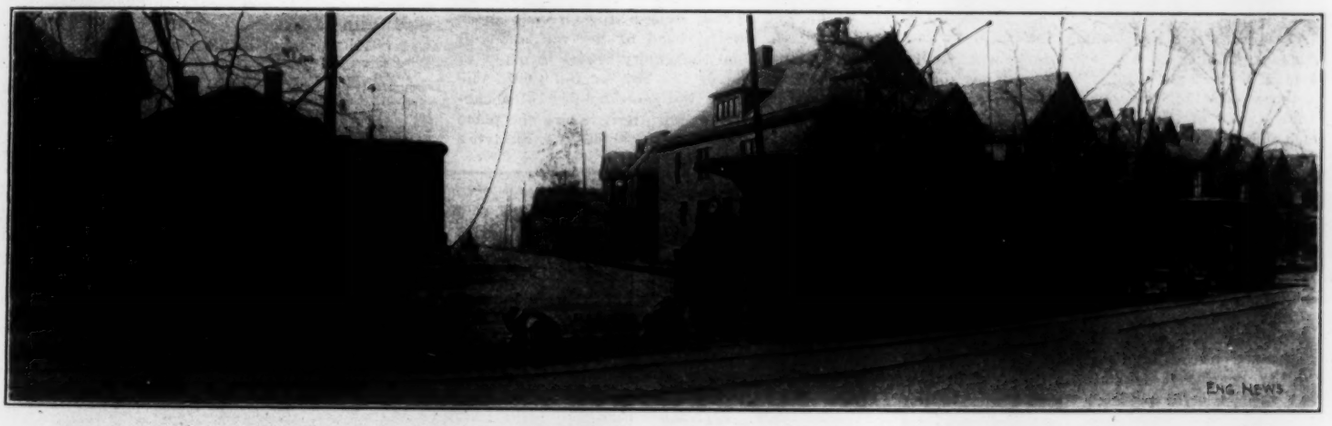
The Electric Welding of Rail Joints in Street Railway Track.

The possibility of laying rails close together in street railway track construction (owing to the fact that rails buried in the pavement are not subjected to the same temperature stresses as those exposed in open track) has led to the extensive use of welded joints which make practically a continuous and unbroken rail. The methods of welding may be divided into two classes: (1) electric welding, in which splice bars are welded to the rails, but the rails themselves are not welded to each other; (2) cast welding (including the thermit process) in which molten metal is cast around the joint, and the rail ends are raised to such a temperature as to become united, thus eliminating the joint entirely. Both methods have been used extensively and with success.

In the reconstruction of the tracks of the Chicago street railways the electric welding system has been adopted. The system employed is that of the Lorain Steel Co., of Johnstown, Pa. (which owns the patents), and for the information here given we are indebted to Mr. H. F. A. Kleinschmidt, Superintendent of the company's track-welding department, who developed and perfected the system. The process comprises three distinct operations: (1) cleaning the metal by a sand-blast; (2) welding the bars to the rails, and (3) grinding the running surface of the rail heads at the joint. The apparatus for these operations is mounted on four self-propelling trolley cars: (1) the sand-blast car; (2) the welding car; (3) the converter car, which is coupled to the welding car; and (4) the grinding car. The group of cars is shown above.



CARS CONTAINING APPARATUS FOR ELECTRICALLY WELDING RAIL JOINTS IN STREET RAILWAY TRACK.

(The first car contains the sand-blast apparatus for cleaning the rail ends. The second car carries the welding jaws, and coupled to it is the third car containing the rotary converter and electrical apparatus. The fourth car carries a swinging frame with emery wheels for grinding the rail heads smooth at the joint.)

but those used in Chicago are of slightly different external appearance. In practice, also, the cars are farther apart than shown in the view.

The car for sand blasting contains a motor-driven air compressor and a sand-blast apparatus; also a storage tank to hold about 2 cu. yds. of dry sand. By an air pressure of about 15 lbs. per sq. in. sand is blown through a nozzle and this sand jet quickly removes all rust and foreign matter from the rails and bars at the points to be welded.

The bars used are 1 1/16-ins. thick, 3½ ins. wide and 22 ins. long. They have three raised portions or bosses rolled on one surface, these bosses projecting about ⅛-in. from the surface of the bar. The bars (having been sand-blasted) are placed in position at the joint, with the bosses against the web of the rail and the middle boss directly over the juncture of the webs of the two rails. A bar is placed on each side so that the bosses are opposite each other.

The welding car is then moved into place and the jaws of the welding apparatus are brought down to straddle the rail, engaging the bars on either side at the middle of the joint. The current is then turned on and that portion of each bar in contact with the rail, and the rail itself where it comes in contact with the boss of the bars, soon comes to a welding heat.

When this welding heat is reached, the current is cut off, and at the same time the horizontal jack between the tops of the levers carrying the welding jaws is pumped up, forcing the upper ends of the levers apart so that a powerful pressure is exerted on the jaws, pressing the bars forcibly against the rail web. The ends of the bars are then welded to the rails in the same way. The bosses or projections on the bars disappear when the pressure is exerted, being compressed into the metal of the web and thus forming the weld. No space remains between the bars and the rail web after the three bosses have been welded, as the bars are then forced into close contact with the web of the rail over their entire surface. Fig. 3 shows the welding apparatus in position at a rail joint.

The apparatus for supplying the current for heating the bars and rails consists of an inverted rotary converter, which changes the direct current (from the trolley) to an alternating current. The alternating current is then passed through a regulator which is simply an alternating-current transformer in which the ratio of the primary voltage to the secondary voltage may be changed at will by means of suitable switches. If the line voltage is constant at 500 volts, the alternating current is passed through the regulator with the windings so arranged that the alternating current passing out to the welder is held practically constant at 275 volts. If the line voltage is higher than 500 volts, the connections are changed to reduce the alternating-current voltage as it comes from the rotary converter. In this way the current at the welding transformer is kept practically constant regardless of the line voltage, and the apparatus can be operated on direct-current voltages varying from 325 to 625 volts.

The rotary converter and regulator, with switchboard and instruments, are carried in a car coupled to the rear of the welding car, by means of a coupling which permits of a certain range of movement for the welding car, without moving the converter car. When these two

cars are moved up to a joint they need be placed only approximately, the converter car remaining stationary during the time the joint is being welded, while the welding car moves from the center weld back to one end of the bars and then forward to the other end.

The final operation is that of grinding the head of the rail to the joint, to remove any inequalities and leave a true running surface for the car wheels. The grinding apparatus (Fig. 2) consists of two swing frames (one over each rail) fitted with emery wheels which are mounted

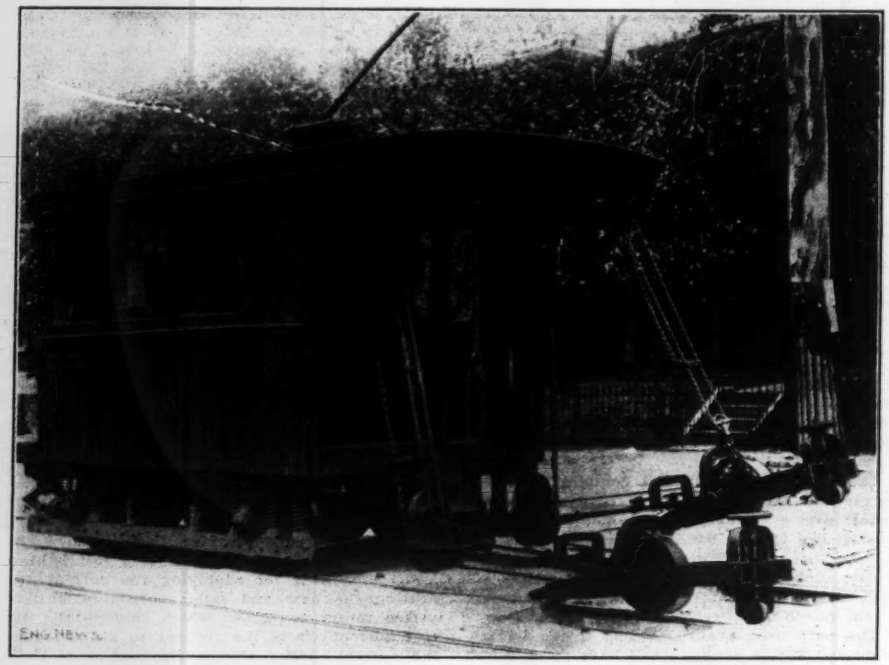


FIG. 2. THE GRINDING APPARATUS FOR FINISHING THE JOINT.

The welder itself consists of an alternating-current transformer in which the ratio of the primary winding to the secondary winding is 44 to 1. A single loop of heavy copper forms the secondary winding, of which the two bars and the web of the rail (when the jaws are in place for welding) complete the circuit. A magnetic switch in series with the primary winding is used to make or break the circuit, thus turning on or off the welding current. This current is of about 7 volts pressure with 10,000 amperes flowing ordinarily. A welding heat is reached in from 2 to 2½ mins. Immediately a welding heat is reached and the current has been cut off, a pressure of about 37 tons is exerted on each bar, forcing them against the web of the rail, and this pressure is retained until the metal has cooled below a glowing heat. It is claimed for this process that the powerful pressure exerted on the hot rail works the metal and thus prevents any deterioration which might result from simply heating the metal without working it.

The welding transformer, with the two large levers on each side for communicating the pressure to the weld from the hydraulic jack at the top, hangs on a bail suspended from a ball joint on a crane at the front of the car. The crane is provided with a motor for raising and lowering the apparatus, and also a motor for moving it from side to side to engage either rail. The required pressure for the hydraulic jack is obtained from a hand pump bolted to one of the arms on the side of the welder. This pump is provided with two pistons, one of large area used to take up the slack, and one of small area by means of which a pressure of 5,000 lbs. per sq. in. can be developed in the jack.

This car carries a motor-driven centrifugal pump for circulating water through the welding transformer and through the jaws of the welder; it has also a blower for forcing air through the hot water as it comes from the welder in order to reduce its temperature again before it returns to the storage tanks which are carried on the car. After the bars have been welded in place the two cars move ahead over the welded joint to the next joint.

in a carriage having rollers at each end; these are let down on the head of the rail and roll back and forth as the emery wheel is made to grind the surface of the rail at the joint. The action is very much the same as that of a carpenter's plane, the emery wheel taking the place of the bit. Old track in which the receiving rail has become worn or dished is ground until a true surface is regained. The emery wheel being supported on the roller grinds only the high places. There are two 5 HP. motors for operating the emery wheels. The rest of the car is taken up with lockers, etc., for supplies; also a small desk for the foreman to make out his reports, keep his records, etc.

When carried on as a continuous process it takes about 15 minutes to complete a joint. The Lorain Steel Co. has five of these outfits at work in different cities. One of these is supplied with adjustable wheels so that the gage can be changed from 4 ft. 6 ins. to 5 ft. 4½ ins. which latter is the widest gage at present in use for street railways in this country.

For track laid in paved streets no provision is made for expansion or contraction of the rails, and any length of track is welded up solid, with the rail ends butted close together as described. On exposed T-rail track, such as [illegible] interurban roads, a special form of expansion joint is employed, these joints being placed at intervals of about 1,000 ft. on straight track and at the ends of all curves and special work.

No trouble is experienced on track where the joints are welded in this way and the delay of operation of cars due to joints is eliminated. The present process was first introduced in 1897, since which time upwards of 1,500 miles of track have been welded.

Comparative Trials of the Scout Cruisers "Birmingham," "Salem" and "Chester."*

Machinery Installations.

The principal dimensions of the three vessels tested are given in Table I. Steel is used throughout and the hulls are alike except in minor particulars. The data on the propelling machinery of the three vessels is summarized in Tables II. to IV. for ease of comparison.

The boiler plants of all three vessels are of the same general design; 12 water-tube boilers of the express type are installed in three separate water-tight compartments. The "Birmingham" and "Chester" have duplicate boilers, in which the products of combustion make two passages across the tubes in going to the uptake at the rear end. These two vessels have in each boiler plant 37,992 sq. ft. of heating surface and 596 sq. ft. of grate area. The boilers of the "Chester" have the same total grate area but only 32,040 sq. ft. of heating surface. The gases here make a single passage across the tubes in going to the uptake, entering around the tubes near the front. In all vessels the general arrangement, number and location of the fire rooms, smoke pipes, etc., are identical.

BIRMINGHAM.—The engines, turn the propellers outboard and are a vertical, inverted, four-cylinder, direct-acting, triple-expansion type, with unjacketed cylinders, placed in two water-tight compartments, and operating twin

*From a report issued by the Navy Department on comparative trials of scout cruisers "Birmingham," "Salem" and "Chester," and from other information on the backing trials, furnished by Rear Admiral H. I. Cone, Engineer in Chief, U. S. Navy, Chief of Bureau, Washington, D. C.

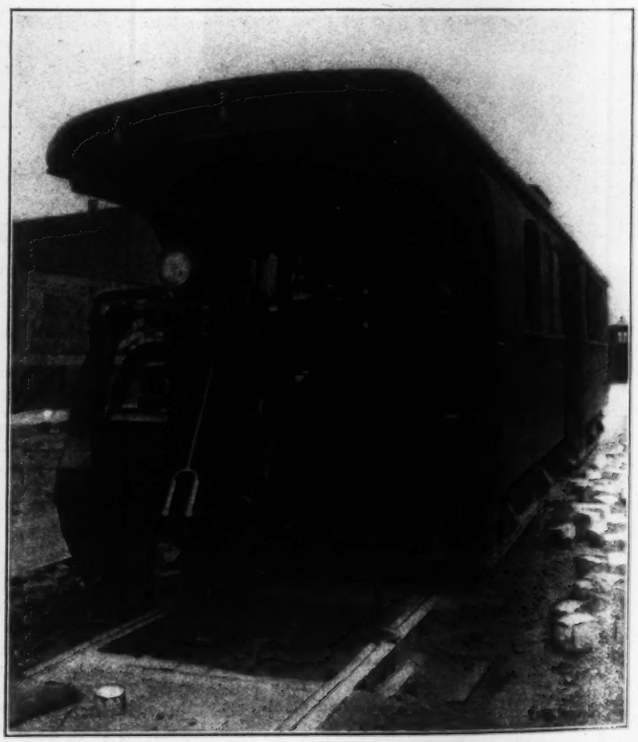


FIG. 3. THE ELECTRIC WELDER IN USE ON THE TRACK RECONSTRUCTION WORK OF THE CHICAGO STREET RAILWAYS.

TABLE I.—PRINCIPAL HULL DATA U. S. SCOUT CRUISERS "BIRMINGHAM," "CHESTER," "SALEM."

Length between perpendiculars	420 ft.
Length over all	423 ft. 2 ins.
Length on L. W. L.	420 ft.
Breadth, molded	46 ft. 8 ins.
Breadth, extreme	47 ft. ¾ in.
Ratio of length to beam	8.97
Draft:	
Official contract trial, 3,750 tons displacement	16 ft. 9 ins.
3,000 tons displacement	17 ft. 4½ ins.
3,710 tons displacement (about fully loaded)	19 ft. 2¾ ins.
Displacement per inch at mean draft (16 ft. 9 ins.)	31.07 tons
Area of midship section (3,750 tons displacement)	566 sq. ft.
Area of L. W. L. section (3,750 tons displacement)	12,960 sq. ft.
Wetted surface section (3,750 tons displacement)	19,900 sq. ft.
Coefficient (at 3,750 tons displacement):	
Block	0.40
Midship	0.72
L. W. L. plane	0.66

TABLE II.—PROPELLING EQUIPMENT OF U. S. SCOUT CRUISER "BIRMINGHAM."

CYLINDERS:	
Number for each engine	4
Diam., h. p.	28¼ ins.
Diam., l. p.	45 ins.
Forward l. p., diam.	62 ins.
After l. p. diam.	62 ins.
Diameter of piston rods	6 ins.
Stroke of all pistons	36 ins.
PROPELLERS (manganese bronze):	
Number of blades	3
Diameter	12 ft. 6 ins.
Pitch (as set), mean	15 ft. 3 ins.
Pitch, adjustable	14 ft. 6 ins. to 16 ft. 6 ins.
Ratio of diameter to pitch	1.22
Area, projected	40.8 sq. ft.
Area, helicoidal	49.4 sq. ft.
Area, disk	122.7 sq. ft.

screws. Each engine was designed for 8,000 I. HP. at 200 r.p.m., with a gage pressure of 250 lbs. Beginning forward, the order of the cylinders is: forward l.p., h.p., i.p. and after l.p. The forward l.p. and h.p. cylinder cranks are opposite, as are the i. p. and the after l.p., the second pair being at right angles with the first. All main valves are a piston type, worked by double-bar Stevenson links. There is one piston valve for the h.p. cylinder, and two each for the i.p. and l.p. cylinders. The machinery equipment is summarized in Table II.

CHESTER.—The propelling machinery in this vessel consists of Parsons marine turbines driving four independent propeller shafts. There are in all six ahead turbines and two backing turbines, the latter located in each of the low-pressure casings. It should be noted that this arrangement permits of a reversal of the two inboard shafts only. The high-pressure and low-pressure "cruising" ahead turbines were intended for use at low powers to secure economy. The outward shafts are operated entirely by the main h.p. turbines; the starboard inboard shaft by a l.p. turbine and the h.p. cruising turbine, and the port inboard shaft by a l.p. turbine and the i.p. cruising turbine. The important data of the turbines are given in Table III.

SALEM.—This vessel is driven by twin screws, turning outboard. The propelling machinery consists of two Curtis impulse marine turbines, one on each shaft, designed to develop 8,000 B.H.P. each, at 350 r.p.m. with 250 lbs. gage pressure. The machinery is arranged in two water-tight fore and aft compartments, the starboard screw being operated by the forward turbine.

Each turbine has a diameter of about 120 ins., center to center of buckets, and for the ahead motion consists of seven stages; each wheel is fitted with three rows of buckets, except in the first stage, which contains four rows. For backing, there are two stages, the rotors being mounted on the shaft in the same casing as the ahead stages. The principal propeller data is shown in Table IV.

Object and Description of Tests.

The object of the tests undertaken was to compare the steam economy of three types of propelling machinery fitted in these three vessels, whose hulls had been made as near as possible of the same model) operated under identical conditions. To facilitate such tests, special water-measuring tanks were installed in each ship and arranged so that the weight of steam used by propelling machinery as well as by auxiliaries could be correctly determined after condensation.

TABLE III.—PROPELLING EQUIPMENT OF U. S. SCOUT CRUISER "CHESTER."

			Diameter rotor drum, ins.	Length rotor drum, ins.	Heights, ins.	Pitch, ins.	Clearances, ins.
TURBINES:							
Cruising, h. p.			60	36			
Cruising, l. p.			49	60.5			
Main HP. (port and starboard)			42	103.5			
L. p. (port and starboard)			65	53⅜			
Astern (port and starboard)			50	43			
Stages.	Expansions.	Rows.					
Cruising h. p.:							
First	First	12			⅜	⅞	0.03
Second	Second	12			½	⅞	0.035
Third	Third	12			⅝	1	0.04
Cruising l. p.:							
First	First	15			1⅛	1¼	0.04
Second	Second	15			1 7/16	1¼	0.04
Third	Third	15			1¾	1 5/16	0.045
Main h. p.:							
First	First	12			⅞	1¼	0.03
Second	Second	12			1¼	1¼	0.035
Third	Third	12			1¾	1 5/16	0.04
Fourth	Fourth	12			2½	1⅜	0.045
Fifth	Fifth	12			3½	1 7/16	0.05
Sixth	Sixth	10			5	1 13/16	0.05
Main l. p.:							
First	First	5			2½	1 5/16	0.055
Second	Second	5			3½	1⅜	0.06
Third	Third	4			5	1 13/16	0.07
Fourth	Fourth	3			7	1⅜	0.08
Fourth	Fifth	3			7	1 15/16	0.08
Fourth	Sixth	4			7	2 5/16	0.08
Fourth	Seventh	4			7	2 5/16	0.08
Astern turbines:							
First	First	6			½	1⅛	0.045
Second	Second	6			1	1⅜	0.05
Third	Third	6			1	1⅜	0.06
Third	Fourth	6			2	1½	0.06
Third	Fifth	6			2	1½	0.06

PROPELLERS (manganese bronze, cast solid).

Number of propellers	4
Number of blades (each propeller)	3
Diameter	6 ft.
Pitch	6 ft.
Ratio of diameter to pitch	1
Area, projected	17.02 sq. ft.
Area, helicoidal	19 sq. ft.
Area, disk	28.27 sq. ft

To make the comparisons complete, six series of tests were carried on; (1) tests of auxiliary machinery, (2) boiler evaporative trials, (3) standardization runs over a measured mile, (4) for steam consumption of main and auxiliary machinery with vessels under way, (5) coal-consumption tests for long trips at various speeds, (6) a full power run of 24 hours duration. It is pointed out in the report issued by the Navy Department that the coal consumption trials did not furnish a wholly correct basis comparison because of the personal element in firing and because of differences in the boiler plants of the vessels. The standardization runs over the measured course were to determine the relation between the vessel speed, in knots per hour, and the speed of the engines, in revolutions per minute. The one-day full-power runs were planned to determine the highest sustained sea speed of the vessels. The "Birmingham" was obliged to discontinue this run after 12 hours on account of a loose crosshead.

Certain backing trials, discussed later, were made to determine the sufficiency of the backing power of turbines for tactical purposes.

TESTS OF AUXILIARY MACHINERY.—While the vessels were at the Boston Navy Yard a series of tests were made to establish the steam consumption of various auxiliaries on each ship. No special provision, other than fitting the necessary gages, counters, indicator gears, was made

TABLE V.—TESTS OF AUXILIARY MACHINERY U. S. SCOUT CRUISERS "BIRMINGHAM," "CHESTER," "SALEM." MAXIMUM AND MINIMUM RESULTS.

	I. HP. Min.	I. HP. Max.	Lbs. gage. Min.	Lbs. gage. Max.	Steam consumption, lbs. per I. HP.-hr. Min.	Steam consumption, lbs. per I. HP.-hr. Max.
Main air pumps:						
"Birmingham"	2.8	7.3	183	198	187.4	227.8
"Chester"	7.8	21	50	105	113	182.1
Main circulating pumps:						
"Birmingham"	1.8	48.9	15.7	104.4	33.5	121.8
"Salem"	3.6	161.6	46	193	24.7	84.1
"Chester"	9.3	142 9	35	128	22.0	44.2
Main feed pumps:						
"Birmingham"	46 4	66.4	183	198	69.3	70.2
"Salem"	19.8	72.1	165	240	70	89.7
"Chester"	18.1	59.6	153	254	77.4	131.6
Engine-room fire and bilge pumps:						
"Birmingham"	5.6	11.1	46	99	103.4	105.2
"Salem"	2.6	7	56	87	102 1	161.2
"Chester"	4.1	13.3	56	120	97.2	130.8
Forced-draft blowers:						
"Salem"	3.2	35.9	41	149.5	59.2	117.8
"Chester"	3 3	39.4	42.0	143	51.4	106.4
Electric generating sets:						
"Birmingham"	20.6	55.7	107	109	33.3	48.5
"Salem"	20.4	55.7	110	112	26.1	30.8
"Chester"	20.4	53 8	96	103	20.5	29.1

—Diameter of cylinder for each stage (inches).—

First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.
60⅜	61	61⅛	..	..	..	..
51¼	51⅞	52.3	..	..	..	..
43⅜	44.5	45.5	47	49	52	..
70	72	75	79	79	79	79
51	52	54	54	54	..	..

TABLE IV.—PROPELLER DATA U. S. SCOUT CRUISER "SALEM."

Number of propellers	2
Number of blades	3
Diameter	9 ft. 6 ins.
Pitch	8 ft. 8½ ins.
Ratio diameter to pitch	1.09
Area, projected	36.8 sq. ft.
Area, helicoidal	43.7 sq. ft.
Area, disk	70.9 sq. ft.

to prepare auxiliaries for test. It was aimed to operate each machine under service conditions. To simulate such conditions, a back pressure of about 6 lbs. per sq. in. above atmosphere was maintained in the auxiliary exhaust line. It was usual, before the commencement of an auxiliary test, to test the system as a whole for tightness. This merely called for an examination of the air-pump discharge after starting the auxiliary condenser, the absence of water being taken as indicating that the exhaust line was clear and that the condenser was free from salt-water leaks.

The report of the special board on the comparative trials allows a general comparison of steam consumption. This has been attempted in Table V. for the principal auxiliaries only.

BOILER TRIALS.—A series of evaporative tests were made on the "Salem" and "Chester" using only the two after boilers. This was considered sufficient to compare boiler efficiencies under different rates of combustion. While these trials were made in port, effort was made to simulate service conditions and the boilers were fired by the regular ship's force of average good firemen. Coal was weighed on platform scales in the fire rooms and at the beginning of each test fires were leveled so as to leave the same amount of fuel on the grates. It was planned to use the same kind and grade of coal in all tests but on account of the movement of the vessels this was inconvenient. It was considered unnecessary to make tests of this kind on the "Birmingham" because of its similarity of boiler installation to the "Salem."

The boilers installed on the "Salem" under approximately similar conditions as to consumption of coal show a higher thermal efficiency than the type on the "Chester." This is due in part to the larger percentage of heating surface in the Salem boilers and in part to the more tortuous passage for the products of combustion.

The characteristic figures shown in Table VI. have been taken from the data in the official report on these trials.

STEAM CONSUMPTION TRIALS OF MAIN PROPELLING AND AUXILIARY MACHINERY.—This group comprises tests to fix the steam consumption of the three vessels at different sea speeds and were considered by the board in charge as the most important as the object was to establish the comparative consumption of the three types of propelling machinery from about ten knots to maximum speed. It was necessary to guard against unlike conditions of underwater hull and of weather and sea conditions. An attempt was made to keep a uniform mean displacement of 4,000 tons by adding water ballast as coal was consumed.

The vessels were fitted with separate and similar water-measuring tanks and the tests on each were undertaken at different times as the ships could be spared. After the propelling machinery had been regulated to the desired speed to accord with the standardization speed-revolution curve about half an hour was allowed to intervene before recording data, to guard against irregular operation and to allow the machinery to settle into final working conditions. Power of the main propelling machinery was calculated on the "Birmingham" from indicator cards; on the "Salem" and "Chester" it was necessary to use

TABLE VI.—COMPARISON OF BOILER TRIALS. U. S. SCOUT CRUISERS "SALEM" AND "CHESTER." (MADE ON TWO BOILERS ONLY ON EACH VESSEL).

	"Salem."		"Chester."	
	Test No. 1.	Test No. 4.	Test No. 4.	Test No. 3.
Duration	12 hrs.	6 hrs.	10 hrs.	12 hrs.
Lbs. gage	242	247	252	258
Furnace draft, ins.	0.17	2.66	Natural	1.2
Temperatures, F.:				
Fire room	115°	95°	88.7°	62°
Feed water	127°	111°	215°	98°
Gas uptake	476°	684°	602°	973°
Coal	Georges Cr.	Georges Cr.	Eureka.	Eureka.
B.T.U. per lb	14,430	14,370	14,548	14,320
Per cent. moisture	1.44	1.11	1.92	2.0
Per cent. ash	6.65	7.16	6.76	7.61
Thickness fire, ins.	5	9	5	9
Dry coal per hr. per sq. ft. grate area	17.09	61.20	18.23	54.28
Do. per hr. per sq. ft. heating surface	0.313	1	0.396	1.179
Combustible per hr. per sq. ft. grate area	18.96	56.83	17.33	51.18
Do. per hr. per sq. ft. heating surface	0.292	1.041	0.376	1.112
Steam:				
Per cent. moisture	0.241	0.671	0.143	0.401
Lbs. water per hr.	19,177	56,611	19,780	44,117
Lbs. water from and at 212° per lb. dry coal	11.28	9.07	9.88	8.26
Do. per lb. combustible	11.91	9.67	10.40	8.76
Boiler efficiency*	75.49	60.96	65.58	55.84
Flue gas:				
CO_2 per cent	7.16	10.10	9.14	9.65
CO	9.06	9.15	9.81	9.43
O	0.88	1.23	0.53	0.23

*Heat absorbed per pound of combustible divided by heat value per lb.

torsion meters of the Denny-Johnson type to find shaft horse power.

These tests were of two general classes (1) when the exhaust from auxiliaries was led into feed-water heaters and (2) where the exhaust went also to the low-pressure engine receivers or to some stage of the main turbines. The Board calls attention to the fact that the larger the percentage of auxiliary exhaust steam delivered to the main engines or turbines, the greater the speed and power developed, the highest speed and power for a given steam consumption being when the feed heaters were not in use. While the apparent economy then reaches a maximum, this does not represent the maximum economy of coal consumption, for the use of sufficient auxiliary exhaust in the feed heaters to give about the maximum feed-water temperature, increases the water evaporated in the boilers for a given amount of coal more than enough to compensate for adding that part of the exhaust to the low-pressure steam.

In these steam-consumption trials on main machinery; the Board recognized the importance of obtaining uniform water rates under like conditions. The weight of condensed steam was checked at frequent intervals and each test was continued until a reasonable agreement of such results was found. Nearly all the tests covered a period of two hours and this was held to be long enough to secure reliable data when the fluctuations in water rates were small.

The important results of these tests are abstracted in Table VII.

COAL CONSUMPTION RUNS.—Four coal-consumption runs were planned with the vessels in company and therefore subject to the same weather and sea conditions. These tests were to be of 100, 50, 100 and 24 hours duration at approximately 10, 15, 20 and 25 knots per hr. respectively. It was considered essential for accurate comparison to use the same grade of coal on all vessels for all trials and Bradford, R. I., was selected as an operating base to that end. Before coaling, an estimate was made of the amounts needed to secure a displacement of 4,000 tons. The corrected displacements were computed from drafts taken at the beginning and end of each run. The engineer's force regularly assigned to each vessel was maintained; the rating of the personnel differed slightly for each vessel but it was considered impossible to equalize the ratings or to frame any comparisons of the efficiency of the three personnels.

Attention was concentrated on an accurate determination of the coal consumed but sufficient readings were made to claim a close calculation, from previous tests, of the steam used by all pieces of machinery.

Four methods of measuring the coal were considered; (1) weighing all coal as taken from the bunkers, (2) using coal in bags of known content, (3) tallying buckets taken from bunkers and ascertaining average weight at intervals, (4) marking the bunkers at intervals of 100 cu. ft. so that, by leveling at the beginning and end of a run, the cubic feet of coal taken from each bunker could be found. The Board held that each of these methods has some peculiar errors for determining actual weight. On account of the crowded fire rooms the first scheme was not held feasible at high speeds; the second was rejected as it was believed that the bags would be ripped and coal would be spilled while the expense of bagging would be prohibitive; the third scheme was rejected because of its having been found unsatisfactory and inaccurate in practice due to cumulative errors in tallying and in heaping coal on the buckets.

The fourth method was selected as having the probability of least error and that due only to improper filling of pockets around beams, etc., and to relative proportions of lumps and s... In all the trials determination was first ma... cubic feet of coal consumed and these fig... were reduced to weight. By weighing and m... uring the loads of the small cars used in co... an average figure of 43.5 cu. ft. per ton of ... was obtained. At the instant of starting the ... the fire-room floors were swept clean, or ... amounts of coal thereon were estimated, an... doors on the bunkers from which coal was t... taken were raised. Coal for use in going to ... from trials was taken from other bunkers w... ever possible. During each trial the coal ... sampled for analysis. The moisture content ... about 1.4%, the ash 6%, the volatile ma... about 21% and the calorific value about 14,... B. T. U.

On the full-power run, the vessels were perm... ted to proceed over an established course at t... highest possible speed. A number of 180° tur... were made to bring all vessels within reasonab... distance of each other when becoming too wid... separated. The "Birmingham" was unable to continue this trial beyond 12 hours because of a knock in the i. p. crosshead of the forward engine after four hours. A leak in the receiver piping of the same engine began soon after the trial opened but this had only the result of showing an abnormal loss of steam and consequent increase of "make-up" feed water.

The results of these trials are summarized in Table VIII. The boiler evaporation has been compared with that on the evaporation trials; total steam was carefully calculated with due allowance for auxiliaries used intermittently and it has been assumed that all "make-up" water was converted into steam. A higher equivalent evaporation is shown by this trial for the "Birmingham" (at 10 knots) and the "Chester" (at full power) than shown on the boiler trials. The Board has attempted no explanation of this.

BACKING TRIALS.—In the beginning of experience with marine turbines attention was naturally centered on their engineering characteristics, such as steam consumption, and on details of construction and operation. With the satisfactory development of these elements, more attention has been given to the tactical features involved, as affecting the ease of handling turbine-engined vessels.

With reciprocating engines a backing power about equal to the ahead power is afforded without any increase in weight except that of the backing eccentrics, rods and links. With turbines, however, backing power requires additional turbines with a considerable increase in weight. It is necessary therefore to restrict the backing power of turbines to that actually required by tactical considerations. The practice has been to provide a backing power estimated at about 50% of the ahead power. It has been found, however, in practice that this backing power is rather less than 40% of the ahead power.

TABLE VII.—HORSEPOWER AND STEAM CONSUMPTION TRIALS. U. S. SCOUT CRUISERS "BIRMINGHAM," "SALEM" AND "CHESTER."

Test No.	Knots per hr.	Horsepower. Main Engines or turbines. *	Auxiliaries. **	Total. ***	Condensed Exhaust. Per Hour. Main engines or turbines.	Machinery for propulsion.	All purposes.†	Per Knot. Main engines or turbines.	All purposes.†	Per HP.-hr. Main engines.	Propelling machinery.	Auxiliary exhaust to.
"Birmingham":												
1	10.03	987.2	52.1	1,039.3	21,998	26,689	33,797	2,192.2	3,369.5	22.3	25.7	Aux. condenser.
2	10.65	1,162.7	48.0	1,210.7	.....	.....	33,292	.....	3,216.0	...	...	Receivers.
8	19.86	6,767.7	208.2	6,975.9	109,820	127,241	130,982	5,529.7	6,595.3	16.2	18.2	Aux. condenser.
9	20.00	6,976.5	177.8	7,154.3	.....	.....	131,322	.....	6,566.1	...	...	Receivers.
10	24.15	13,670.4	528.5	14,198.9	253,372	288,834	294,923	10,491.6	12,212.1	18.5	20.3	Aux. condenser.
"Salem":												
1	10.01	719.6	131.66	851.3	30,182	38,636	44,783	3,015.2	4,473.8	42.0	45.4	Aux. condenser.
4	10.06	723.2	122.06	845.3	.....	.....	40,523	.....	4,028.1	...	...	Third stage.
10	17.43	4,614.0	191.97	4,806.0	92,325	105,804	110,582	5,297.0	6,344.3	20.0	22.0	Aux. condenser.
9	17 44	4,624.0	215.27	4,839.3	.....	.....	107,859	.....	6,184.6	...	...	Third stage.
11	25.12	18,070.0	681.92	18,759.9	292,751	332,373	338,754	11,654.1	.....	16.2	17.7	Aux. condenser.
"Chester" (six turbines):												
27	10.15	908.0	152.0	1,060.0	25,492	37,641	43,411	2,511.5	4,276.9	28.1	35.5	Aux. condenser.
7	18.03	5,699.2	199.0	5,898.2	94,082	109,279	114,534	5,218.1	6,352.4	16.5	18.5	Aux. condenser.
8	18.15	5,977.5	184.8	6,162.3	.....	.....	112,645	.....	6,206.3	...	...	l. p. turbines.
(five turbines):												
9	10.43	828.5	126.8	955.3	33,927	44,347	97,993	3,252.8	4,601.4	40.9	46.4	Aux. condenser.
10	10.56	826.4	125.1	951.5	.....	.....	46,164	.....	4,371.6	...	...	Second stage h. p.
16	20.00	8,154.3	245.7	8,400.0	119,369	137,376	140,100	5,968.0	7,005.0	14.6	16.4	Aux. condenser.
17	20.14	8,368 8	245.1	8,613.9	.....	.....	136,649	.....	6,785.0	...	...	l. p. turbines.
(four turbines):												
14	15.81	3,613.0	183.6	3,796.6	77,252	93,172	94,880	4,886.3	6,001.2	21.4	24.5	Aux. condenser.
15	15.68	3,463.8	180.3	3,644.1	.....	.....	93,864	.....	5,986.2	...	...	l. p. turbines.
18	20.05	7,834.7	284.8	8,119.5	132,651	151,585	156,954	6,616.0	7,828.0	16.9	18.7	Aux. condenser.
19	20.05	7,849.5	297.3	8,146.8	.....	.....	154,749	.....	7,718.0	...	...	l. p. turbines.
28	24.67	18,544.0	606.9	19,150.9	253,662	290,861	295,687	10,282.2	11,904.6	13.7	15.2	Aux. condenser.

*Shaft horsepower; in the case of turbines determined directly; in the case of engines indicated horsepower was converted by multiplying by 0.94.
**Indicated horsepower.
***The sum of shaft and indicated horsepower. Used by Board on account of uncertainty of finding equivalent shaft horsepower of auxiliaries.
†All purposes except for lift pumps needed in measuring condensed steam.

TABLE VIII.—COAL CONSUMPTION TRIALS, U. S. SCOUT CRUISERS "BIRMINGHAM," "SALEM" AND "CHESTER."

Ship	Displacements, tons.	Knots, per hour.	Horse power — Main engines or turbines.*	Horse power — Auxiliary.†	Horse power — Total.‡	Steam — Actual from and at 212° per lb. coal.	Steam — Evap. trials from and at 212° per lb. coal.	Coal — Tons per day.	Coal — Lbs. per hour.	Coal — Lbs. per hour per knot.	Lbs. per sq. ft grate area per hour.	Lbs. per H.P.-hr., all propelling machinery.
"Birmingham"	3,994.0	9.86	902.4	61.4	936.8	11.60	11.12	32.14	2,999	304	17.02	3.11
"Salem"	4,022.0	9.90	668.4	115.1	783.5	9.52	10.85	53.85	5,026	508	21.67	6.41
"Chester"	4,026.9	10.03	730.0	105.1	835.1	9.54	9.64	42.06	3,926	391	16.92	4.90
"Birmingham"	3,960.0	19.83	7,120.5	188.7	7,309.2	9.62	10.90	153.45	14,322	722	20.58	1.96
"Salem"	4,030.5	20.25	6,884.3	329.0	7,212.3	9.54	10.60	202.03	18,855	931	27.09	2.61
"Chester"	3,970.3	19.90	8,374.0	206.2	8,580.2	9.55	9.44	162.90	15,205	760	21.84	1.77
"Birmingham"	4,039.0	24.00	13,938.4	535.9	14,474.3	8.42	9.52	375.72	25,070	1,461	50.38	2.42
"Salem"	4,028.0	24.32	14,630.0	695.8	15,325.8	8.36	9.25	415.15	38,749	1,593	55.74	2.53
"Chester"	3,961.6	25.08	19,632.0	463.6	20,095.6	8.70	8.03	429.40	40,078	1,598	57.42	1.99

*Shaft horsepower; in the case of turbines obtained directly; in the case of engines indicated horsepower converted by multiplying by 0.94.
†Indicated horsepower.
‡The sum of the two preceding quantities—shaft and indicated horsepower. This is used by the Board on account of the uncertainty of finding shaft-horsepower equivalent for the small auxiliaries. The final column shows pounds of coal per hour per horsepower combined similarly.

Trials have been held with the three scout cruisers, since the other runs were completed, to determine the sufficiency of the backing power provided respectively by Parsons and by Curtis turbines, and as compared with that obtained by reciprocating engines. The criterion has been taken as the distance headreached by the vessel during the interval required to bring her to dead stop in the water from a given speed ahead.

These trials were conducted with great care and throughness, the conditions of displacement, sea, speed, and number of boilers in use, were practically identical for all, and the results are reported by the Navy Department as an authoritative indication of the relative backing powers of the three types of machinery as now installed. The speeds selected for the trials were 10, 16, 22 and 24 knots. At each speed only the boilers required for a sustained run at this speed were used. There was no bottling up of steam preparatory to backing, and no speeding up of blowers during the backing interval. It was required that the boiler pressure be not reduced to such an extent as to cause priming.

The results of these trials may be seen in Table IX. It will be noted that at all speeds the reciprocating engine provides better backing power than the Curtis turbines, and that the latter is superior to the Parsons turbine.

The average time required for reversing, and the fall in boiler pressure during the backing intervals were as follows:

	Average time to reverse.	Average drop in boiler pressure.
Parsons turbines	8.2 seconds	82.4 lbs.
Curtis turbines	39.2 seconds	75.8 lbs.
Reciprocating engines	5.1 seconds	None

In the case of the "Birmingham," the average boiler pressure at the end of the backing interval was 1.5 lbs. greater than at the beginning of the interval.

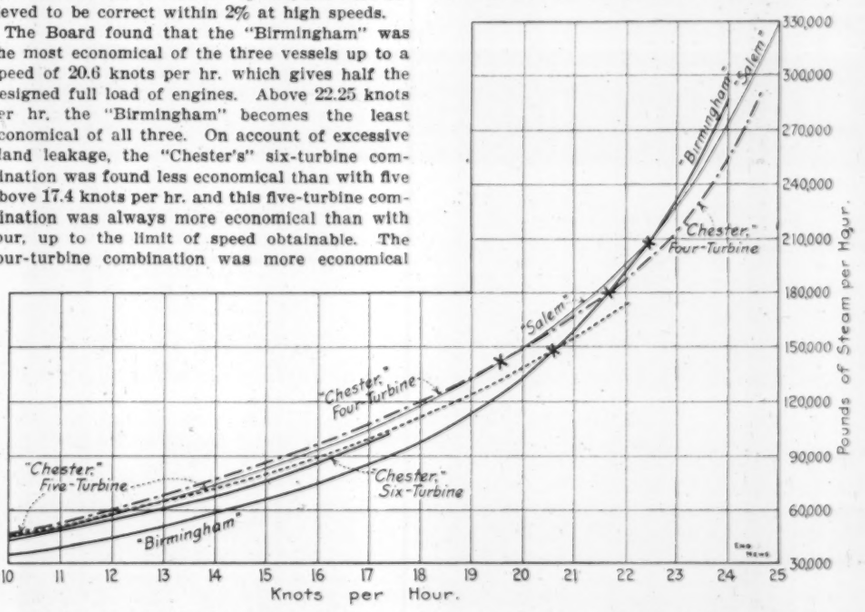
Accuracy of Data and Conclusions.

The Board found that the most reliable measurements were on revolutions per minute of main propelling machinery. In recording condensed water collected in steam consumption trials, little error was expected in number of full collecting tanks and errors would reside in inaccurate measurements of incomplete tanks at beginning and end of tests. As such errors would be distributed over a long time interval, their effect was held negligible. In apportioning amounts of steam used by auxiliaries in tests in which all condensed exhaust was measured as a whole, the performance data from auxiliary machinery tests were used and the results were regarded as close approximations only. Speed was determined from revolutions per minute of propelling machinery according to the data from standardization runs. These speed figures were corrected by stadimeter observations and the greatest variation was about 2.3%. The maximum error on steam-consumption trials was held to be less than 2% as all weather conditions were favorable.

The power data for the "Birmingham" was considered by the Board as accurate as can be determined from any high-speed engine indicator readings. The figures for shaft horse power, on the "Salem" and "Chester" were admitted open to as much as 20% error at low speeds, but were believed to be correct within 2% at high speeds.

The Board found that the "Birmingham" was the most economical of the three vessels up to a speed of 20.6 knots per hr. which gives half the designed full load of engines. Above 22.25 knots per hr. the "Birmingham" becomes the least economical of all three. On account of excessive gland leakage, the "Chester's" six-turbine combination was found less economical than with five above 17.4 knots per hr. and this five-turbine combination was always more economical than with four, up to the limit of speed obtainable. The four-turbine combination was more economical than the "Salem's" equipment above 19.45 knots.

The "Birmingham's" condenser equipment required the least steam during all trials except at full power when the "Salem" used 6% less. The "Chester" showed the greatest expenditure, showing that her air pumps and augmenters were greater consumers than the "Salem's" wet and dry vacuum pumps. The "Chester's" forced draft installation showed an economy of steam per indicated horse power over the others varying from 6% at low powers to 16% at high. Moreover at 10 and 15 knots per hr., the "Chester" steamed at natural draft while the others required forced draft.



CURVES OF TOTAL STEAM CONSUMPTION OF U. S. SCOUT CRUISERS "BIRMINGHAM," "SALEM" AND "CHESTER," AT SPEEDS OF 10 TO 25 KNOTS PER HR.

TABLE IX.—COMPARATIVE BACKING DATA U. S. SCOUT CRUISERS "BIRMINGHAM," "SALEM" AND "CHESTER."

Ship.	Knots per hr.	Mean draft.	Displacement, tons.	Time to stop. From reversal signal.	Distance head reached, lengths.	
"Birmingham"	10.00	19 ft. 7.3 ins.	4,856	1 min. 10.3 secs.	1.5	Average of three runs.
"	16.07	19 ft. 7 ins.	4,851	1 min. 21.2 secs.	2.6	Average of three runs.
"	21.75	19 ft. 6.4 ins.	4,836	1 min. 3 secs.	3.0	Average of two runs.
"	23.40	19 ft. 6.4 ins.	4,833	1 min. 9 secs.	3.2	One run.
"Salem"	10.00	19 ft. 8 ins.	4,877	1 min. 20.4 secs.	1.8	Average of three runs.
"	16.00	19 ft. 7 ins.	4,846	1 min. 27.3 secs.	3.0	Average of three runs.
"	22.00	19 ft. 7 ins.	4,846	1 min. 37.0 secs.	4.2	Average of two runs.
"	24.00	19 ft. 7 ins.	4,846	1 min. 40.5 secs.	4.7	One run.
"Chester"	9.85	19 ft. 8 ins.	4,950	1 min. 52.7 secs.	2.2	Average of four runs.
"	15.79	19 ft. 7 ins.	4,842	2 mins. 6.0 secs.	4.3	Average of three runs.
"	22.00	19 ft. 4 ins.	4,785	2 mins. 8.5 secs.	5.4	Average of two runs.
"	24.25	19 ft. 4 ins.	4,785	2 mins. 51.0 secs.	6.5	One run.

An Old Irrigation System in Switzerland.

In the valley of Zermatt, located among the high Alps and near the famous Matterhorn, there is a system of irrigation canals which is notable because its principal object, apparently, is not to apply water to the fields in time of drought, but to fertilize the soil. The flanks of the high peaks about Zermatt are covered with glaciers, and the water which flows from the glaciers in this part of the Alps is almost milk-white with a fine sediment ground from the rocks by the glaciers. Not only the Visp River and its tributaries which flow through the valley of Zermatt are white with this rock powder, but the Rhone River itself, of which the Visp is a tributary, is white or gray all the way until it empties into the Lake of Geneva. The rock dust settles here and the lake itself is famous for its clear azure water.

The Zermatt valley lies at an elevation of nearly 5,000 ft. above sea-level, but streams from the glaciers at much greater elevation enter it at many points. The irrigating canals are of insignificant size; but considerable labor must have been expended in their original construction, as they are carried along embankments, so as to bring them above the level of the land to be flooded. The water is diverted from the streams to the head of the canal by crude wooden troughs placed at the head of some fall or rapids. The fields are irrigated by flooding, a flat stone making a temporary dam in the canal and causing it to overflow. As the climate is a humid one, the proximities to the glaciers making clouds and showers frequent, it is believed that the irrigation system would not be maintained and used for the water alone; and that benefit to the soil from the impalpable mineral matter carried in suspension in the water is the real purpose of the irrigation. The irrigation canals and embankments appear to be of great age.

Formulas for Use in Detailing Steel Structures.

By HART VANCE.*

Besides hips and valleys and skew portals (the computations necessary in detailing which have been already exhaustively formulated in Engineering News†) the subjects most likely, in ordinary practice, to embarrass the draftsman not specially prepared are hoppers and the various forms of towers with inclined columns or "legs." The present article represents an endeavor to make most readily available in such cases the applicable formulas developed in spherical trigonometry.

The eleven principal and six check equations

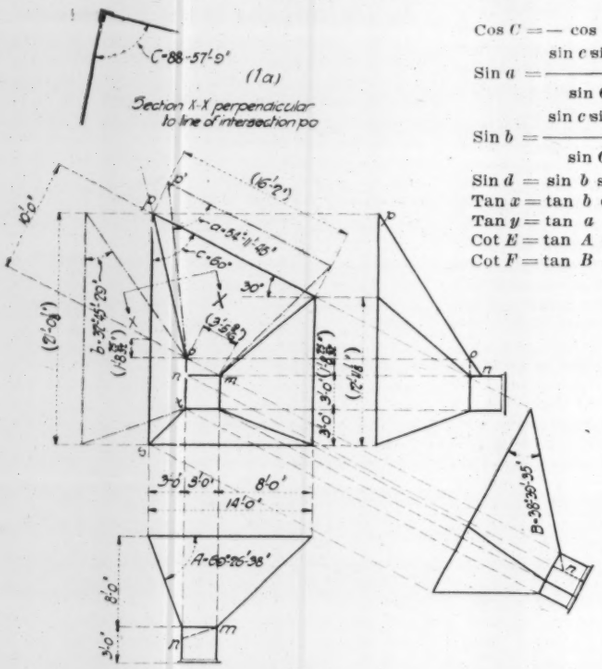


Fig. 1.

assembled below for this purpose not only afford the means of determining all the angles required in detailing hoppers or towers, and of verifying the calculations, but may be used as well in regard to any bent plate, provided the computer can select or project the requisite plane of reference.

Ordinarily in the case of a hopper, only the first three of the principal equations are brought into use, but the attachments or supporting structure may be such as to necessitate employment of the next five.

The elements involved may be defined as follows:

Given.

A = angle between plane of one side and horizontal plane;

B = angle between plane of other side and horizontal plane;

c = angle in horizontal plane between its intersections with the planes of the two sides.

Required.

C = angle between planes of the two sides;

b = angle in plane of first side, between its intersections with plane of other side and horizontal plane;

a = corresponding angle in plane of other side;

x = angle in horizontal plane between its intersections with the plane of the first side and a vertical plane through the intersection of the planes of the two sides;

y = corresponding angle between intersections of plane of other side and of same vertical plane.

$x + y = c$;

d = angle in this vertical plane between its intersection with the horizontal plane and the intersection of the planes of the two sides;

E = angle between the plane of the first side and this vertical plane;

F = angle between the plane of the other side and the same vertical plane;

$E + F = C$.

In the preceding, for *horizontal plane* we may substitute *any plane of reference* which may be most convenient for the case in hand. At the same time, of course, wherever the words *vertical plane* occur we must read *plane normal to plane of reference.*

FORMULAS.

$$\text{Cos } C = -\cos A \cos B + \sin A \sin B \cos c. \quad (1)$$

$$\text{Sin } a = \frac{\sin c \sin A}{\sin C}. \quad (2)$$

$$\text{Sin } b = \frac{\sin c \sin B}{\sin C}. \quad (3)$$

$$\text{Sin } d = \sin b \sin A = \sin a \sin B. \quad (4)$$

$$\text{Tan } x = \tan b \cos A. \quad (5)$$

$$\text{Tan } y = \tan a \cos B. \quad (6)$$

$$\text{Cot } E = \tan A \cos b. \quad (7)$$

$$\text{Cot } F = \tan B \cos a. \quad (8)$$

Check:

$$\text{Tan } E = \frac{\tan x}{\sin d}.$$

$$\text{Tan } F = \frac{\tan y}{\sin d}.$$

These two checks cover all the preceding equations, except Eq. (1). Determination of the angles, a, b, and C, by means of the following, will complete the verification:

$$\text{Tan } \tfrac{1}{2}(a-b) = \sin \tfrac{1}{2}(A - B) \operatorname{cosec} \tfrac{1}{2}(A + B) \tan \tfrac{1}{2} c. \quad (1')$$

$$\text{Tan } \tfrac{1}{2}(a+b) = \cos \tfrac{1}{2}(A - B) \sec \tfrac{1}{2}(A + B) \tan \tfrac{1}{2} c. \quad (2')$$

$$\text{Cot } \tfrac{1}{2} C = \cos \tfrac{1}{2}(a+b) \sec \tfrac{1}{2}(a-b) \tan \tfrac{1}{2}(A + B) \quad (3')$$

Throughout the computations, it will be necessary, of course, to observe carefully the algebraic signs of functions, and it may be convenient to have within view the usual memorandum:

Functions.	1st Quad. 0°-90°	2d Quad. 90°-180°	3d Quad. 180°-270°	4th Quad. 270°-360°
Sines and cosecants.	+	+	—	—
Cosines and secants.	+	—	—	+
Tangents and cotangents	+	—	+	—

Hoppers.

EXAMPLE.—Fig. 1 shows the outlines and some typical details of a hopper, presenting quite as many difficulties as one is likely to encounter in actual practice. Below is given the computation of the angles pertaining to the intersection, *op*, of two of its sides; this will illustrate the entire process.

Of the linear dimensions shown on the drawing, those in parentheses have been derived by simple calculations; the others are data. The upper horizontal plane is taken as plane of reference. The pitch angles A and B are first computed from the given dimensions:

$\tan A = 8$ ft./3 ft. $\qquad \tan B = 8$ ft./10 ft.

log 8 ft. = 0.9030900	log 8 ft. = 0.9030900
3 ft. = 0.4771213	10 ft. = 1.0000000
tan A = 0.4259687	tan B = 9.9030900
$\therefore A = 69°\ 26'\ 38.2''$	$\therefore B = 38°\ 39'\ 35.3''$

As the obliquity of the far edge is given at the right-hand corner as 30°, we have

$$c = 60°\ 0'\ 0''$$

The intersection angle of the two sides, found from Eq. 1:

log cos A = 9.5454599	
cos B = 9.8925781	
9.4380380	$\therefore -\cos A \cos B = 0.27$
log sin A = 9.9714286	
sin B = 9.7956681	
cos c = 9.6989700	
9.4660667	$\therefore \sin A \sin B \cos c = 0.2$
	Cos C = 0.0
	log cos C = 8.2
	$\therefore C = 88°\ 5$

Next, the cut angles a and b are found from (2) and (3):

log sin c = 9.9375306	log sin c = 9.9375306
sin A = 9.9714286	sin B = 9.7956681
9.9089592	9.7331987
− sin C = 9.9999274	− sin C = 9.9999274
sin a = 9.9090318	sin b = 9.7332713
$\therefore a = 54°\ 11'\ 44.7''$	$\therefore b = 32°\ 45'\ 2$

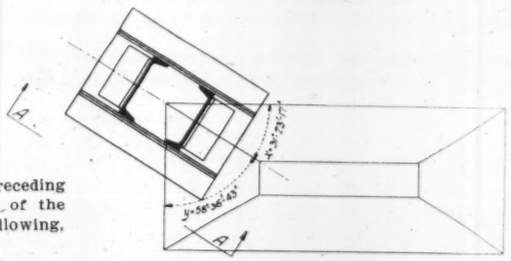
To check these values, use Eq. (1'), (2') and (3') first finding $\frac{1}{2}(A + B)$ and $\frac{1}{2}(A - B)$ by subtraction:

A =	69° 26′ 38.2″
B =	38° 39′ 35.3″
$A + B$ =	108° 6′ 13.5″
$A - B$ =	30° 47′ 2.9″
$\frac{1}{2}(A + B)$ =	54° 3′ 6.75″
$\frac{1}{2}(A - B)$ =	15° 23′ 31.45″

log sin ½ (A−B) = 9.4239380
cosec ½ (A + B) = 0.0917570
tan ½ c = 9.7614394
tan ½ (a−b) = 9.2771344
∴ ½ (a − b) = 10° 43′ 7.9″

log cos ½ (A − B) = 9.9841366
sec ½ (A + B) = 0.2313230
tan ½ c = 9.7614394
tan ½ (a + b) = 9.9768990
∴ ½ (a + b) = 43° 28′ 36.8″
a = 54° 11′ 44.7″
b = 32° 45′ 28.9″

log cos ½ (a + b) = 9.8607284
sec ½ (a − b) = 0.0076447
tan ½ (A + B) = 0.1395661
tan ½ C = 0.0079392
∴ ½ C = 44° 28′ 34.67″
C = 88° 57′ 9.34″



For dimensions of Tower see Fig 3.

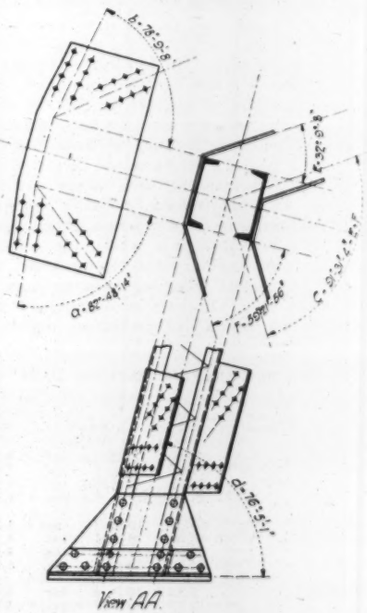


Fig. 2.

*534 Oakdale Ave., Chicago, Ill

†"The Designing of Skew Connection Details for Roof and Bridge Work," by C. A. P. Turner, Eng. News, Feb. 15, 1900 et seq.; and "The Detailing of Skew Portals," by J. P. Davies, Eng. News, Feb. 11, 1910.

These angles, C, a and b, are clearly identified in Fig. 1, an enlarged section of the bent plate connecting the two sides concerned being shown at (1a), and these sides also being developed in broken lines.

The corresponding angles at the other principal intersections, or corners of the hopper, may be ascertained by a similar process, which is simplified at *st*, where the slopes A and B, and hence the angles a and b, are equal, and $c = 90°$; the requisite equations becoming

$$\cos C = -\cos^2 A$$

$$\sin a = \frac{\sin A}{\sin c}.$$

At the intersection, *on*, of the plane of the oblique B-side of the hopper with the plane of a vertical side of the square outlet or throat, extended, the slope B is the same as for *op*, but $A = 90°$ and the computation becomes:

log sin B = 9.7956681	log sin c = 9.9375306
cos c = 9.6989700	− sin C = 9.9777089
cos C = 9.4946381	sin a = 9.9598217
∴ C = 71° 47′ 57.3″	∴ a = 65° 43′ 57″

log sin c	= 9.9375306
sin B	= 9.7956681
	9.7331987
sin C	= 9.9777089
sin b	= 9.7554898
∴ b	= 29° 39′ 40.7″

In the case of the other intersection, *mn*, of the plane of the oblique side with a vertical plane, A and B are the same as in the preceding instance and the equations are unaffected, but $c = 30°$, so that

log sin B = 9.7956681	log sin c = 9.6989700
cos c = 9.9375306	− sin C = 9.9248071
cos C = 9.7331987	sin a = 9.7741629
∴ C = 57° 14′ 53.3″	∴ a = 36° 28′ 41.1″

log sin c	= 9.6989700
sin B	= 9.7956681
	9.4946381
sin C	= 9.9248071
sin b	= 9.5698310
∴ b	= 21° 48′ 5.1″

Towers.

As to towers, there may be indefinite variation in the arrangement of the principal members, but two very distinct types predominate. The first is that in which each of the rectangular columns has two sides parallel with the radial vertical plane in which it leans; the other, that in which two sides of the column are parallel with the plane of one of the sides of the tower.

In the latter case, three additional formulas are needed in order to determine the following relations of the other two sides of the column:

B' = the angle between a plane parallel with these two sides of the column and a horizontal plane;

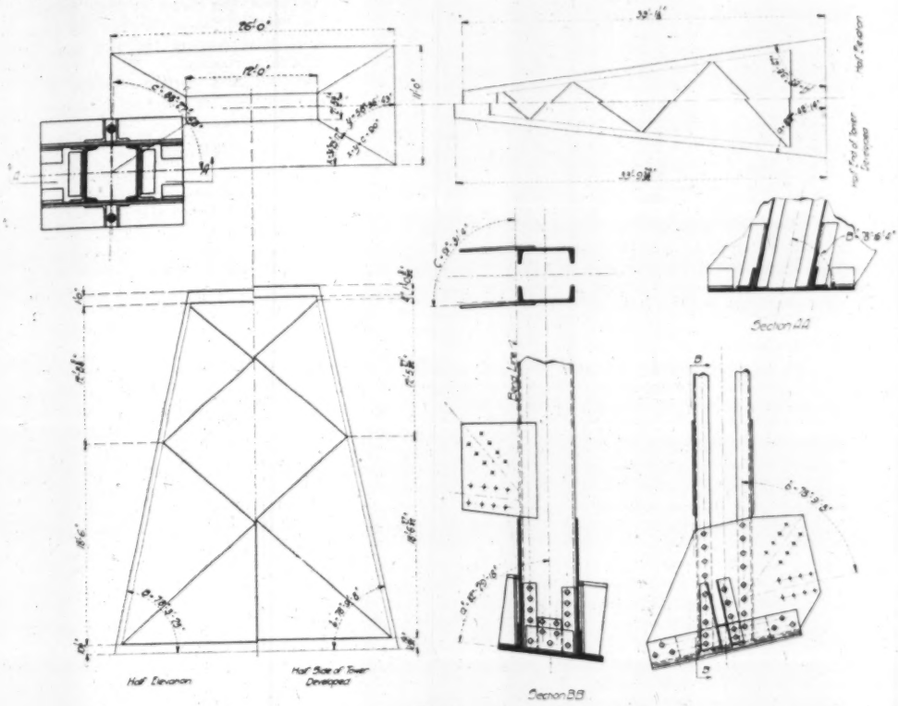


Fig. 3.

a' = the angle in plane of one of these sides, between its intersections with a horizontal plane and with the plane of the adjacent outer side of the column, the latter intersection being, of course, parallel with the axis of the column;

c' = the angle in a horizontal plane, between its intersections with the planes of the two outer sides of the column.

FORMULAS:

$$\text{Cos } B' = \cos b \sin A \quad \ldots\ldots (9)$$

$$\text{Tan } a' = \sin b \tan A \quad \ldots\ldots (10)$$

$$\text{Tan } c' = \frac{\tan b}{\cos A} \quad \ldots\ldots (11)$$

Check:

$$\text{Cos } B' = \frac{\tan a'}{\tan c'}.$$

Figs. 2 and 3 illustrate the construction of towers of the two kinds described and the application of all the formulas presented. The detailing of both structures (though not that of either alone) requires the use of every angle determinable by means of the eleven equations. Towers of the same general dimensions have been taken as examples of the two types, and one computation, employing the full series of equations, will, therefore, serve for both:

11 ft. 0 ins.	26 ft. 0 ins.
2 ft. 5½ ins.	12 ft. 0 ins.
2) 8 ft. 6½ ins.	2)14 ft. 0 ins.
log 4 ft. 3¼ ins. = 0.6305126	log 7 ft. 0 ins. = 0.8450980
33 ft. 1⅛ ins. = 1.5197460	1.5197460
tan A = 9.1107666	tan B = 9.3253520
∴ A = 82° 38′ 47.3″	∴ B = 78° 3′ 24.5″

Horizontal sections of the tower being rectangular, $c = 90°$ and the second term of the second member of Eq. (1) disappears with cos c, the equation becoming

$$\text{Cos } C = -\cos A \cos B$$

cos A	= 9.1071799
cos B	= 9.3158477
− cos C	= 8.4230276
∴ C	= 91° 31′ 3.9″

Since sin c = 1, it may be disregarded as a factor in Eq. (2) and (3), which become

$$\text{Sin } a = \frac{\sin A}{\sin C}.$$

$$\text{Sin } b = \frac{\sin B}{\sin C}.$$

The batter angles in the planes of the sides are then found as follows:

log sin A = 9.9064133	log sin B = 9.9904957
− sin C = 9.9988476	− sin C = 9.9988476
sin a = 9.9965657	sin b = 9.9906481
∴ a = 82° 48′ 14.3″	∴ b = 78° 9′ 8.2″

For the radial tower, Fig. 2, the angle between leg and horizontal plane is angle d, Eq. (4):

log sin a = 9.9965657	log sin b = 9.9906481
sin B = 9.9904957	sin A = 9.9064133
sin d = 9.9870614	sin d = 9.9870614
∴ d = 76° 5′ 0.6″	

The center line of the base-plate makes with the sides of the base the angles x and y, found by Eq. (5) and (6):

log tan b = 0.6782349	log tan a = 0.8987378
cos A = 9.1071799	cos B = 9.3158477
tan x = 9.7854148	tan y = 0.2145855
∴ x = 31° 23′ 17.4″	∴ y = 58° 36′ 42.6″

Check: $x + y = c = 90°\ 0'$.

The bend angles of the gusset-plates for the tower bracing are angles E and F, found from Eq. (7) and (8):

log tan A = 0.8892334	log tan B = 0.6746480
cos b = 9.3124132	cos a = 9.0978279
cot E = 0.2016466	cot F = 9.7724759
∴ E = 32° 9′ 8.0″	∴ F = 59° 21′ 56.0″

And the check equations give:

log tan x = 9.7854148	log tan y = 0.2145855
− sin d = 9.9870614	− sin d = 9.9870614
tan E = 9.7983534	tan F = 0.2275241
∴ E = 32° 9′ 8.0″	∴ F = 59° 21′ 56.0″

$E + F = C = 91°\ 31'\ 4.0''$.

These are all the angles needed for the radial-leg tower, Fig. 2. Checking the angles a, b and C by means of the alternative equations (1′), (2′) and (3′):

A = 82° 38′ 47.3″
B = 78° 3′ 24.5″

∴ $A - B$ = 4° 35′ 22.8″	½ $(A - B)$ = 2° 17′ 41.4″
$A + B$ = 160° 42′ 11.8″	½ $(A + B)$ = 80° 21′ 5.9″
c = 90° 0′ 0″	½ c = 45° 0′ 0″

log sin ½ $(A - B)$	= 8.6025116
cosec ½ $(A + B)$	= 0.0061870
tan ½ $(a - b)$	= 8.6086986
	∴ ½ $(a - b)$ = 2° 19′ 33.08″
log cos ½ $(A - B)$	= 9.9996517
sec ½ $(A + B)$	= 0.7757240
tan ½ $(a + b)$	= 0.7753757
	∴ ½ $(a + b)$ = 80° 28′ 41.22″
	a = 82° 48′ 14.30″
	b = 78° 9′ 8.14″

log cos ½ $(a + b)$	= 9.2185993
sec ½ $(a - b)$	= 0.0003579
tan ½ $(A + B)$	= 0.7695370
cot ½ C	= 0.9884942
	∴ ½ C = 45° 45′ 31.97″
	C = 91° 31′ 3.94″

For the tower of the second type, Fig. 3, we need also the bend-angle for the base and cap connections on the narrow side, B'; the cut angle at base and cap in the plane of the narrow side, a'; and the angle of gage-lines in base and cap c'. These are found by Eq. (9) and (11):

log cos b = 9.3124130	log sin b = 9.9906481
sin A = 9.9964133	tan A = 0.8892334
cos B' = 9.3088263	tan a' = 0.8798815
∴ B' = 78° 15′ 4.0″	∴ a' = 82° 29′ 17.6″

log tan b	= 0.6782351
− cos A	= 9.1071799
tan c'	= 1.5710552
∴ c'	= 88° 27′ 43.1″

Check:

log tan a'	= 0.8798815
−tan c'	= 1.5710552
cos B'	= 9.3088263
∴ B'	= 78° 15′ 4.0″

It is well, perhaps, to remark here that the hopper and towers used as subjects of the foregoing computations were selected not for any excellence in design or detail but merely for their aptness in exemplifying application of the formulas presented.

CLEARANCE OF DIAGONAL BRACING IN TOWERS SUPPORTING TANKS WITH HEMISPHERICAL BOTTOMS.

The detailing of towers may involve also another puzzle—or at least an operation that many

draftsmen find very puzzling at first. This occurs when the proper location of the connections for diagonals passing under the hemispherical bottom of a tank is to be determined. Figs. 4 and 5 state the notation used in the two methods of solving this, which follow.

The only advantage that can be claimed for the first of these, Fig. 4, is that a complete check on the calculation is obtained, as is always the case with equations derived from Spherical Trigonometry.

In this case the requisite data are:

E = angle between plane of side of tower and horizontal plane;

g = angle in horizontal plane, between intersections of plane of side of tower and radial plane through axis of adjacent column;

op = radius of hemisphere plus required clearance of diagonal;

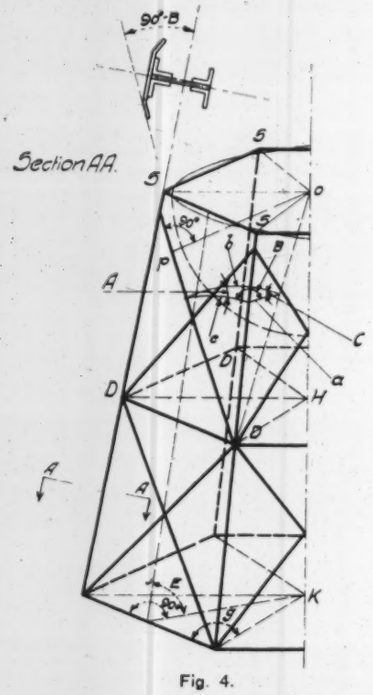


Fig. 4.

oD = distance from center of hemisphere to lower point at which axis of diagonal pierces radial plane passing through axis of column. (This distance, the position of the point D being established, is readily determinable from the general dimensions of the tower: $oD = \sqrt{oH^2 + DH^2}$.)

a = angle SDo;

$$\left[\text{Sin } a = \frac{o\,S \cos DoH}{D\,S}\right]$$

b = angle pDo;

$$\left[\text{Sin } b = \frac{o\,p}{oD}\right]$$

Required, angle c, fixing the position of the diagonal in plane of side of tower.

FORMULAS.

$$\text{Cos } B = \sin E \cos g \quad \ldots\ldots (1)$$
$$\text{Sin } A = \sin a \text{ cosec } b \sin B \quad \ldots\ldots (2)$$
$$\text{Tan } \tfrac{1}{2} c = \sin \tfrac{1}{2}(A + B) \text{ cosec } \tfrac{1}{2}(B - A) \tan \tfrac{1}{2}(b - a) \quad \ldots\ldots (3)$$

Check:

$$\text{Cot } \tfrac{1}{2} C = \tan \tfrac{1}{2}(A + B) \cos \tfrac{1}{2}(a + b) \sec \tfrac{1}{2}(b - a)$$
$$\sin c = \sin C \sin b \text{ cosec } B.$$

The other method is the graphical one, Fig. 5. While especially available for direct graphic determination of the required elements, it is quite adaptable to computation also, as shown in the following equations:

$$1 \ldots\ldots f = b \cos B$$
$$2 \ldots\ldots p = \sqrt{r^2 - f^2}$$
$$3 \ldots\ldots h = e \sec B + b \sin B$$
$$4 \ldots\ldots \tan A = \frac{k}{h}$$
$$5 \ldots\ldots l = \frac{k}{\sin A}$$
$$6 \ldots\ldots \sin C = \frac{P}{l}$$
$$D = A + C$$
$$7 \ldots\ldots m = \frac{k}{\tan D}$$
$$8 \ldots\ldots n = \frac{k}{\sin D}$$
$$9 \ldots\ldots x = \frac{2\,k \cos D}{\sin (B + D)}$$
$$10 \ldots\ldots y = \frac{2\,k \cos B}{\sin (B + D)}$$

Oblique Bends in Riveted Pipe.*

The detailer of large riveted pipe, such as that which is supplied for extensive projects of irrigation in the West, usually has, in cases of deflection, no data but transit and level field-notes—that is to say, measurements only in horizontal and vertical planes. If the deflection happen to be in an oblique plane, the construction of the curve and especially the matching of the rivet-holes in the circular joints between the curved pipe and the straight, are difficult enough to make specific formulas valuable.

Those given below seem to be in the most succinct and available form to which the requisite equations can be reduced:

There are two cases:

I—When the two center-lines of straight pipe OM and ON in Fig. 6, depart in opposite directions from a horizontal plane through their point of intersection.

II—When these center-lines are both on one side of a horizontal plane through their intersection.

The known survey data are:

A = the larger of the two angles between the center-lines of straight pipe tangent to the curve and a horizontal plane.

V = the smaller of these angles.

B = the horizontal projection of the deflection.

It is required to find:

C = angle between the plane of true deflection—i. e., the plane in which both center-lines lie—and a vertical plane through the center-line of pipe having the greater departure from the horizontal.

G = angle between the plane of true deflection and a vertical plane through the center-line of pipe having the less departure from the horizontal.

D = the angle of true deflection—that is, the angle between one center-line and the other extended.

FORMULAS.

$$1 \ldots\ldots \text{Tan } C = \frac{\sin B}{\sin A \cos B - \tan V \cos}$$

$$2 \ldots\ldots \text{Tan } G = \frac{\sin B}{\tan A \cos V - \sin V \cos B}$$

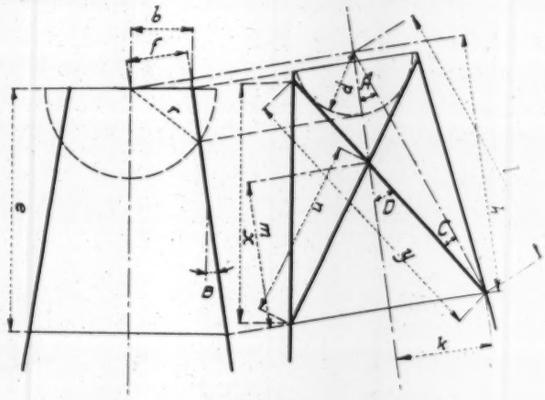


Fig. 5.

$$3 \ldots\ldots \text{Sin } D = \frac{\sin B \cos A}{\sin G} = \frac{\sin B \cos V}{\sin C}$$

Check:

$$\text{Tan } H = \frac{\tan V}{\cos B} \qquad \text{Tan } D = \frac{\tan (A - H)}{\cos C}$$

These equations are true for Case I. Changing minus signs to plus makes them true for Case II.

*It is due the author to state that while this same subject was treated graphically by C. A. Jackson in Eng. News, Aug. 11, 1910, Mr. Vance's article was in our hands several months prior to Mr. Jackson's. Mr. Vance informs us that he developed his formulas and used them for pipe calculations two years ago.—Ed.

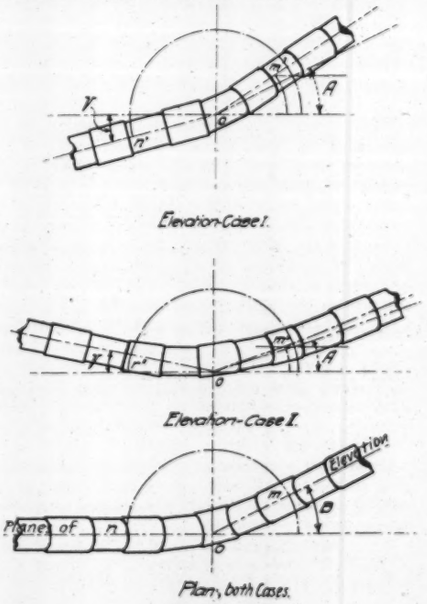


Fig. 6.

RULES FOR THE PROTECTION OF THE WATER-supplies of Kentucky and for the prevention of pollution of the streams of the state have been adopted by the State Board of Health, in accordance with suggestions made by Mr. Paul Hansen, Assoc. M. Am. Soc. C. E., who has recently been appointed as state sanitary engineer of Kentucky. These rules prohibit any municipality, corporation, institution, or person from installing or contracting for the installation of public water-supply or sewerage systems "until complete plans and specifications fully describing such water-supply or system of sewerage have been submitted to and received the approval of the State Board of Health."

Similar prohibitions are made as regards additions or alterations in public water-supplies involving changes in the source of supply or in the methods employed for purifying the water or changes in sewer outfalls or in methods of disposing of the sewage. Corporations, institutions and persons are prohibited from adopting a site for the location of any manufacturing, or other industry, which produces putrescible or otherwise objectionable liquid wastes, until said site is approved by the State Board of Health, or unless some method for adequately purifying such wastes, satisfactory to the State Board of Health, is to be used.

Particular attention will be given by Mr. Hansen to the prevention of a stream pollution by distillery wastes, which has grown to be a serious matter in certain parts of Kentucky, owing to the fact that decomposing distillery refuse creates very foul odors which travel for long distances.

In 1911 it is hoped that a general sanitary survey of Kentucky can be made. In connection with this and other work proposed by the new engineering department of the Kentucky State Board of Health, a staff of some ten technical men, with a water and sewage laboratory, will be needed. It is hoped that legislative appropriation to this end can be secured.

The Second International Road Congress.

By E. L. CORTHELL,* M. Am. Soc. C. E.

At the request of your Editor-in-Chief, now in Europe, and unable, through illness, to attend the International Road Congress at Brussels, Aug. 1 to 6, I will give you some information in reference to certain of the most interesting features of the Congress and its excursions.

In some respects this has been a record Congress. As a speaker at the final reunion of about 250 of the members at the "Banquet d'Adieu" at Namur said, "This Congress in age is an infant, but in size and strength a giant." This was the second Congress, the first having been held nearly two years ago at Paris. This Congress was able to obtain through its permanent Commission at Paris, the adherence of 32 countries of the world, a permanent private membership in almost every civilized country, and a large temporary membership in the Second Congress. In the short time available there were obtained 117 important and useful papers by experts in road construction and maintenance on the subjects offered for discussion, live subjects of interest in all the countries where good roads exist or are proposed.

Nothing has created this extraordinary and new interest so much as the advent of the automobile and motor car for pleasure and business. This new method has brought to the front questions of vital importance to the public which require adequate and early solution. This present Congress has done a good work for humanity, for it has helped to solve the questions of road construction and maintenance, and good roads are a desideratum for the people; for it is by them that the products of the country reach the railroads, the canals, the rivers and the terminals of export and import.

This Road Congress as a permanent institution with its (in the future) triennial meetings, deserves the approval and support of all the governments of the world, and of all those who are interested in the construction and maintenance of good roads.

The Permanent International Association of Road Congress consists of delegates of governments and corporations of all countries which subscribe annually to it, and of private members. The Permanent International Commission is composed of members belonging to the various countries represented in the Association, this representation of the countries being in proportion to the total annual subsidy granted by their governments, each country having the right to one representative for each 1,000 fr. ($200) of its annual subscription to the Association.

While there are quite a number of private members from the United States, our government up to the present time has no representation upon the Commission, as it has not subscribed to the Association. This is to be regretted, for there is no subject before the people of the United States and of the various state governments of greater importance to the public than good roads, and there is no better and more useful means of promoting a knowledge of the best methods of construction and maintenance than a membership in these International Road Congresses.

The method most acceptable to the Permanent Commission and most useful for the public of the United States would be for the United States Government through legislation by Congress to become a permanent member by an annual subscription of a reasonable amount and for each state interested in good roads to contribute through its legislature an annual amount, say 1,000 ft., to be transmitted to the Permanent Commission annually through the National Government, which would entitle the state to a representation upon the Commission, where it would have a voice in the management of the Congress. This is the method adopted in Germany, provinces or kingdoms contributing their annual subscriptions through the Imperial Government. Any state would also be entitled to send a delegate to the Congress or an annual subscription of not less than 250 fr.

*Singer Building, New York City.

To return to the late Congress and its numerous excursions and functions. I have had enough to do in the past 33 years in the way of organizing and attending congresses and annual meetings to appreciate the enormous amount of work in getting together the papers from so many countries and in carrying through the Congress with much success and satisfaction.

The Permanent Commission at Paris furnished in advance all members of the Congress and the governments associated with copies of all the papers on the subjects selected for discussion. The papers were translated into the three languages of the Congress: French, German and English. They were printed in convenient form, in good print and on good paper, each with a paper cover. These were distributed long before the Congress met. The Congress was divided into two sections and two sub-sections. There were nine questions or subjects for papers and discussions. Each of these nine questions had a general reporter, or reviewer, who presented a summary of the papers on his question, with his own views and a recommendation of conclusions for the Congress to adopt. The reports of these reporters were bound into a convenient volume and placed in the hands of all concerned some months before the Congress assembled.

There were nine general reports on as many questions, comprising in all 203 pages.

As an illustration of the ground covered by general reports, take the following title page:

1st Section—Construction and Maintenance. Sub-Division A—Construction and Maintenance Outside of Large Towns.

2d Question—Foundation and Drainage of Roads. Methods of Carrying Out the Work. General Report by H. Michez, Engenieur en chef-Directeur des Ponts et Chaussees of the Province of Luxembourg-Arlon, Belgium.

The report consisted of (1) an introduction, (2) *summary* and *analysis* of reports, Papers 1, 2, 3, 4, 5, 6 and 7, with a summary of each. In these seven reports are represented Norway, Austria, Italy, Belgium, France and the United States—the last by an excellent paper by Mr. Vernon Peirce, Chief Engineer, Office of Public Roads, U. S. Department of Agriculture, Washington. Following the summary of each report comes (3) *Observation and Data.* (4) Proposals of Conclusions on Foundation on Drainage and Method of Construction. (5) Condensed *Summary and Conclusions* on (2) Foundation and (2) Drainage.

Those were debated and edited in open session by Subdivision A of the First Section. Thus agreed to, they appeared the following day in the morning Journal of the Congress for the information of all its members, who were each morning supplied with the Journal. The conclusions thus reached and published in the Journal in three languages, were presented to the full Congress at the final session and voted on, giving in this way the consensus of opinion of this large body of experts on each subject treated.

I think there will be a general agreement that the method of arriving at general conclusions could not be improved upon and that the final literary product of this Congress will be of great utility in respect to all questions affecting roads and streets. [The Conclusions are printed elsewhere in this issue.—Ed.]

The general procedure of the Congress was as follows: On July 30, a reunion of the Permanent International Commissions was held in the Palais de la Nation, where final questions preceding the opening of the Congress on the July 31 were settled.

On Aug. 1, Monday, the Congress was opened with due formalities in the Palais des Academies, admirably adapted to such assemblies. Mr. Dedbeke, Minister of Public Work, Belgium, made the opening remarks, after which President-General of the Congress, Mr. Lagasse de Locht, outlined the work before the Congress. He was followed by Mr. Mathieu, General Secretary of the Permanent Commission. The leading delegates of each country represented at the Congress then spoke a few words on behalf of their government, the United States being represented by Col. Cosby, Engineer of Buildings and Grounds, Washington, D. C.

The Congress then separated into its sections and sub-sections, each having its own hall for meetings. On Saturday, Aug. 6, the final and formal closing of the Congress took place, at which were presented and voted on the conclusions agreed to in each of the sections and subsections.

During the week, and following the Congress, were numerous excursions, receptions and entertainments admirably arranged and quite largely attended by the membership. It would extend this communication too far to go into the details of these functions. A review of them shows that outside of those carried out by the Congress itself and contributed to by those taking part in them, there were over 30 complimentary entertainments in Brussels and other cities of Belgium. To mention a few: A most entertaining excursion to the ruins of the ancient Abbey of Villers, where a dramatic entertainment was given by the Touring Club of Belgium in the open air among the ruins, participated in by about 400 members of the Congress. Two porphyry quarries, one at Lessines and the other at Quenast, were visited. The stone from these quarries is used mostly for paving, generally in "Belgian blocks" of various sizes and for macadam broken up by Blake crushers. There was also an excursion to the sandstone quarries of the Montfort Company, at Poulseur, which, with their admirable installations, were very interesting. At all these quarries the excursionists were entertained by lunches and every possible attention was shown them.

The excursion to Antwerp comprised a visit to the city hall and a reception there by the mayor; a visit to the cathedral and the museum; a carriage ride given by the city, which passed entirely around the extensive maritime docks; a trip on the Scheldt, below and above the city, in two steamboats; a reception by the Minister of Public Works, who lives in Antwerp, and a visit to the Zoological Garden.

At the Universal Exposition in Brussels, a visit to the department of civil engineering and the road exhibit, the latter showing in the open court, by actual pavements, the methods of building Roman and modern roads from the first century to the present time. Pamphlets with full descriptions and diagrams, sections and historical notes were furnished.

Other interesting excursions were made to Ostend Spa, the Grotto of Han, near Rochefort, and to the Namur. Some of the excursionists went by rail and some by automobiles from Liege, covering by the latter method in two days about 400 kilometers (245 miles). As it was my good fortune to go by automobile, I will briefly refer to a few of the interesting features of this trip.

Each excursionist, about 100 is all, was supplied with a guide book, which gave in detail the general technical conditions and constructions of the roads passed over, as well as the methods of maintenance, also a map of the route. During the first day, Aug. 9, starting early in the morning from Liege, the ground to Spa was well covered. The Falls at Coo were visited and an opportunity given to examine the great Gileppe Dam, which forms a reservoir which supplies the woolen goods manufacturing city of Verviers, 6 miles distant, with an abundant supply of water.

The two parties, one by rail and one by automobiles, joined each other near Spa at the Hotel Balmoral, owned by the Spa Extension Co., where an excellent luncheon was offered by that company to the whole body of excursionists. This hotel is on an elevated plateau, beautifully situated and reached by an excellent road or by trolley, also built and owned by this company. The night was spent at Spa and an opportunity given after a reception by the mayor and aldermen to visit the very interesting ferruginous baths of this well known health resort.

On the following day, Aug. 10, the automobile and rail excursion was continued to Namur, visiting en route Rochefort, and, by the courtesy of the railroad, the Grotto of Han, where the River Lesse enters and passes through the mountain, and where one can, by the steam tram, reach the point where it enters the mountains and pass thence through a succession of caves and pass-

ages, finally making the exit from the bowels of the mountains. The passageways have been artificially made convenient for a very extended trip through these marvellous caves. The caves are now lighted by electricity, and thus all the wonders and beauties are brought to view as one passes up and down and through the midst of the most beautiful stalactites and stalagmites and columns and vaulted caverns.

Namur was reached before sundown, and an ascent made in automobile to the heights above the city, where formerly the citadel controlled, in the wars of a past age, the approaches to this fortified city of Belgium. Now the city has converted this lofty plateau into a field of sports and an amphitheatre for the drama in open air.

The greatest pains were taken to give in the guide issued for our use full information as to the construction and maintenance of the roads over which we passed in the automobiles; the kind of stone, the mixture, the foundations, the surface and all the data required for a complete knowledge of the road. As I had this in my hand with the map of the route, the entire 400 kilometers, I felt sure at the end of the two days that I knew more about the roads of this part of Belgium than I had ever gained by passing over any system of roads I had ever traversed.

I cannot close this hasty and very brief account of this Congress without expressing my admiration of the manner it has been conducted, both in regard to the technical study and discussion, and for the opportunity given to see the roads of Belgium and to examine many other interesting features of that very interesting and enterprising country.

The people of Belgium have shown themselves to be most kind and hospitable, and have spared no pains to make the visit of the members of the Congress as pleasant as possible, and every convenience has been given to make the sessions and the excursions satisfactory. Everything has passed off as outlined in the printed program prepared weeks in advance, showing an ability, difficult to exceed, in handling large numbers of people.

The local organization of the Congress on whom fell the responsibility of all the meetings and excursions deserve the greatest credit. The President of the Congress, Mr. Lagasse, the General Secretary, Mr. Walin, and the secretary in charge of excursions, Mr. Genard, all merit the greatest praise for their perfect management of the Congress. Mr. Lagasse, who stands at the head of the engineers of the Belgium government, was untiring in his attention to the comfort of the members, and he labored unceasingly to make the Congress and its excursions a complete success. His constant presence, his urbanity and great versatility and happy expression on all occasions endeared him to every member of the Congress, and we all feel that we have in him a personal and devoted friend.

In fact, it may be said, as was expressed at the closing banquet, that the people of Belgium, from the king to the contoniers (patrolmen) of the roads, showed a hospitality, good will and cordiality that was truly remarkable and deserves all praise.

Final Conclusions Adopted By the Second International Road Congress, at Brussels.

Nine main "Questions" were made the subject of consideration at the International Road Congress, held at Brussels, Belgium, early in August, 1910 (see report of Congress preceding this article). The "Final Conclusions" reached as the result of deliberations on these questions were doubtless the result of more or less compromise among the delegates from various countries. We print the conclusions, as follows:

I. Metalled and Paved Roads.

USE OF BINDING MATERIALS IN THE CONSTRUCTION OF METALLED ROADS.

The Congress believes that it is desirable to pursue and develop the applications of the use of binding materials in the construction of metalled roadways, special attention being given:

(1) To determine in each case the character of the binder best suited to local conditions.

(2) To determine as exactly as possible the physical and chemical characteristics to be specified for tar, bituminous, asphaltic or other binders as best suited.

(3) To compare the different results obtained in various methods of construction.

(4) To investigate the influence that storing of tarred metal during a more or less extended period, before being used, may have upon the perfection of the work.

(5) To make a study of the deteriorations that the materials are subjected to during use.

(6) To specify the system to be advised where ordinary metalling has proved deficient and stone paving cannot for some reason be applied.

(7) To establish for each district, according to local conditions and in each case, the relation between cost and the result obtained.

USE OF TRACKWAYS IN PAVED ROADS.

Apart from exceptional cases depending upon local conditions, the construction of trackways [for ordinary vehicles—Ed.] in paved roadways can be considered but an expedient.

PROGRESS MADE IN COMBATING WEAR AND DUST.

Confirming the resolutions passed at the Paris Congress in 1908, the Congress believes:

(1) That superficial tarring may be considered as definitely accepted in practice, and that the advantage to be derived from spreading fine sand or suitable stony material after tarring and rolling the same is not at present proved, and should form the object of comparative tests.

(2) That in the future application of these methods the attention of road builders could be drawn with benefit to the comparison of results obtained by the laying of tar, bituminous or asphaltic substances—hot or cold—by machine or by hand, both from the point of view of cost and from the point of view of the efficiency of the operation.

(3) That it is desirable, in comparing results, to take into account the quantity of the materials composing the metalling, the intensity of traffic and tonnage, as well as the climate.

(4) That with due regard to the resources of each region in tar, bituminous or asphaltic substances, it is important to specify in contracts the conditions that are to be fulfilled, especially as regards the preservation of "life"; that is to say, the property of preserving their binding power.

(5) That it would be desirable that a comparison be established between the advantages of tarring—this word being taken in its broadest sense—in different cases; whether the operations are to be frequently repeated, small doses being applied each time, or whether larger quantities are to be applied at greater intervals. Furthermore, whether, in the metalling itself, a tar, bituminous or asphaltic binding material has already been incorporated or not.

(6) That the conclusion adopted by the first Congress is to be maintained in toto, running as follows: Emulsions of tar or of oil, hydroscopic salts, etc., have a real but not a lasting efficiency. Therefore, their use should be limited to special circumstances, such as on race courses, and in connection with festivals, processions, etc.

II. Foundation and Drainage of Roads.

(1) The formation and construction of foundations of roadways should be made the stronger in proportion to the lesser compactness of the ground. The foundation should have more body and resistance, the more it is exposed to internal deterioration and external wear.

(2) In the choice of the system of foundation for roadway, both stone sett and metalled, stress should be principally laid on the degree of dryness and dampness of the subsoil, while having regard to the possibility of their drainage and to their geological nature and to the nature of the materials of the locality.

DRAINAGE.

(3) In soils where preliminary drainage is required before construction the general methods of drainage should be applied to the whole or to a part of the road body and to the bed of the metal if necessary.

(4) The cross and longitudinal sections of roads and those of side gutters should be established so as to facilitate the flow of trickling water and to prevent infiltration of water into road surfaces, which should be made as impermeable as possible. The evaporation of superficial dampness should be encouraged by every means.

(5) The works for the foundation and for drainage should be carried out simply and economically, and by using the materials of the country so far as possible.

III. Light Railways and Tramways.

(1) In the study of the new roads to be constructed both in the neighborhood of large towns as well as in the open country, it may be useful to try to provide a sufficient road width for the construction of a light railway outside of the roadway.

The designs should be of such a kind as to provide for every kind of traffic.

It is desirable that the supplementary costs [illegible] be defrayed by the owners of the light railway [illegible] as the part of the road reserved for the rail tr[illegible] concerned.

(2) The construction of sunken rails in the [illegible] roadways is always harmful to the viability of [illegible] and there results a marked increase in cost [illegible] maintenance. It is desirable that this method [illegible] be avoided as much as possible.

The presence of tramway rails in paved roads [illegible] the repair of the paving very difficult where the [illegible] abuts against the rails. It is necessary to d[illegible] that nuisance as far as possible by appropriate m[illegible]

(3) Where the railway is placed by the side of the road it is preferable, where the width of the roa[illegible] mits, to construct it on a special track, inac[illegible] to wheeled traffic and super-elevated in order to [illegible] greater safety.

It is necesary in all cases to provide [illegible] drainage.

In the case of metalled roadways, the owners of the railway should be obliged to construct on the outside border of the roadside a depot for materials for the repair of the road; the same obligation should be in some cases extended to paved roads.

(4) The removal of trees from roadsides should not be tolerated unless in special cases.

If the width between the tree rows is insufficient for the rail track to give the necessary width for ordinary wheel traffic, the track should be laid on the outside of the trees.

(5) It is desirable that the owners of light railways should assist the work of maintaining the area of the road or roadway occupied by the rails or contiguous to same or pay the costs of this maintenance.

IV. Cleansing and Watering.

Throwing refuse upon the public roads should be carefully avoided. Such refuse should be removed by the municipality and not by the owners of adjoining property, provided the cost of this work is recovered from the latter.

In large towns it is necessary to give special care to cleansing and watering.

Cleansing should be done as rapidly as possible.

Watering must be frequent and limited in amount according to local conditions.

Washing and sweeping should be done as early as possible. Mechanical processes are particularly recommended.

Improvement in the implements should be sought for with a view of ensuring the most complete cleansing with the least inconvenience to the public.

Motor machines can be advantageously used for cleansing and road watering in large towns.

V. Choice of Surfacing Materials.

(1) Macadam causes dust and mud, is expensive to maintain, and is suitable in large cities only for streets where the traffic is not very great or heavy.

(2) The experimental work carried out in recent years with macadam improved by using a bituminous or tarry coating of binder must be continued in order to determine the best methods of utilizing this kind of construction under varying conditions, so that this question may be submitted again at the next conference.

(3) Stone pavement has great qualities of resistance and durability. Its maintenance is easy and economical; it produces hardly any dust, and is suitable where there are tramway tracks.

(4) It should be adopted in thoroughfares whenever noise is of little consequence or when wood or asphalt surfaces are not suitable. It should consist of setts [blocks] regular in shape, durable, but not slippery, wearing evenly, and laid upon a foundation and with close joints.

(5) The Congress desires to see the trials of small sett pavements continued wherever local circumstances and traffic conditions permit.

(6) Wood paving is noiseless; not slippery if kept clean; it stands very heavy traffic. The use of it should be extended even to thoroughfares through which run tramway lines.

(7) The respective advantages of soft and hard wood blocks must be a subject of discussion at a forthcoming Congress.

(8) Asphalt pavements should be recommended owing to their good qualities from the hygienic point of view and their ease of cleansing and of repair. This surfacing is almost noiseless and produces but little dust, but it is unsatisfactory adjacent to tramway rails.

(9) There is opportunity for its use in fashionable thoroughfares where the traffic is not severe, where there are no tramways, and where the grades are very moderate.

(10) Finally, the trials of asphalt flag and block pavements should be continued.

VI. Distribution Systems Under Roads.

(1) It is desirable to free as far as possible the carriageways from the minor distribution systems of pipes

which now encumber them and to leave in them only the large sewers and mains which require little attention.

(2) As far as possible the minor distribution pipes which are connected to the adjoining houses should be doubled and placed on both sides of the street. This doubling is especially recommended for streets with heavy traffic and also for those where the surface rests on a solid foundation.

(3) It is advisable to consider the advantages of placing all distribution systems except gas in subways of suitable dimensions under the footways. In this case great care must be taken to prevent flooding caused by breakage of water pipes.

(4) When the distribution works have been actually placed under the carriageway, the Congress advises that the system of doubling should be applied prudently by taking advantage of the opportunity given by considerable repairs or alterations.

(5) Complete agreement is necessary between all authorities interested in the streets in order to conduct their operations so as to interfere as little as possible with the traffic. It is most desirable that all street works should be under the general direction of those responsible for maintaining the surface. The work must be carried out as rapidly as possible, and so as to reduce the space occupied on the public highway and the obstruction to traffic.

(6) Trees planted in the footways in urban districts should be chosen so as not to inconvenience the frontagers by their leaves nor to interfere by their roots with the distribution systems.

VII. Influence of Weight and Speed of Vehicles on Bridges, &c.

(1) The development of mechanical traffic has not had up to the present the effect of increasing the weight of vehicles generally beyond the limits recognized by regulations and custom in connection with constructional calculations. In any case it is desirable that when existing regulations are revised steps should be taken to test bridges by placing upon them the heaviest probable loads under the most unfavorable conditions and exclusively composed of mechanical vehicles.

(2) Under the present conditions of constructing motor vehicles and building public roads it does not seem possible that the speed of vehicles could have any effects on modern and well-built bridges which have not already been duly taken into account in the usually-adopted methods of calculations of strength. It may be advisable, however, when testing new bridges or retesting bridges to make use of the heaviest motor-driven vehicles permitted to run, and running them at high speed.

(3) The consolidation (solidarization) of the different parts of which bridges are composed aids their capacity to withstand the effects of vehicular traffic.

VIII. Design of Road Vehicles.

ANIMAL-DRAWN VEHICLES.

(1) Heavily-loaded vehicles with narrow tires may cause exceptional damage to roads laid down for general traffic.

(2) It is desirable that trials should be taken in hand for the purpose of determining the relation which should exist between the load, the diameter of wheel, and the width of tread, so as to avoid abnormal damage.

MECHANICALLY-DRAWN VEHICLES.

(1) Such automobiles as fall under the head of "touring cars" cannot cause abnormal damage to the roads so long as their speed is kept within limits.

(2) Public-service automobiles cannot cause appreciable damage to the road provided that the maximum speed does not exceed 25 kilometers [15.5 miles] per hour; that the maximum axle-load does not reach 4 [long] tons on the heaviest-loaded axle.

(3) Commercial motors need not cause exceptional damage to a well-constructed road provided that the following limits are adhered to: First type—vehicles in which the axle-load is less than 4½ [long] tons; maximum speed, 16 kilometers [10 miles] per hour.

In the narrow streets in towns and large cities, when vibrations of the ground are to be feared, it is possible to minimize the inconvenience by reducing the speed in a suitable degree.

Second type—vehicles in which the maximum axle-loads are between 4½ and 7 [long] tons per hour.

It is desirable that experiments should be taken in hand in order to determine the maximum width of the tires of all automobiles while still ensuring that under normal conditions the distribution of the load on the ground should take place over the whole supporting area.

(4) Ribbed or grooved iron tires cause abnormal damage to the road no matter what their width or what load they support.

(5) Vehicles propelled by mechanical power cannot cause extraordinary damage to the curved portions of roads provided that at these points a sufficient superelevation is given, and that the curved portion is not approached or traversed at an unreasonable speed.

(6) With a view to saving the roads it is desirable that car builders should go carefully into the question of clutches and brakes, so that the skidding of the wheels may be avoided, balance the motors as perfectly as possible, and allow a reasonable raising of the center of gravity.

IX. Motor Omnibuses.

The Congress is of opinion that public motor omnibus service should be encouraged. As a final resolution the Congress is of opinion at the present moment to decide definitely on the respective advantages of the two modes of transport, but that one forms the complement of the other and not the rival, and the adoption of one or other method largely depends on local conditions.

The progress of motor-omnibus traffic and the extent of the use of this method of transportation is capable of great extension—(a) by the use of wheels fitted with rubber tires; (b) by any progress made in construction. The number of passengers carried by motor omnibuses should be greater for the town than for the country.

The Physical Meaning of Entropy.

By A. L. MENZIN.*

To define "Entropy" as a mathematical expression involving heat and temperature without any attempt at direct physical interpretation, or as a thermal property of matter analogous to some other physical property, is hardly satisfactory. From a simple equation based on the efficiency of a Carnot cycle the writer arrived at the definition stated below. It may be of interest to note that this definition harmonizes with two somewhat different definitions previously advanced—one attributed to Clausius and another by Mr. James Swinburne.

First, it is desirable to restate a few principles of thermodynamics. That which does work is heat. The working substance is merely the medium for the conversion of heat into work, and as such it is as much a part of the mechanism required as the engine itself. Since heat can only be converted into work through the agency of a medium which contains heat as its intrinsic energy, a consideration of the work possible from external heat alone must always include the return of the working substance to its initial state—that is, the physical state of the working substance must pass through a cycle of change.

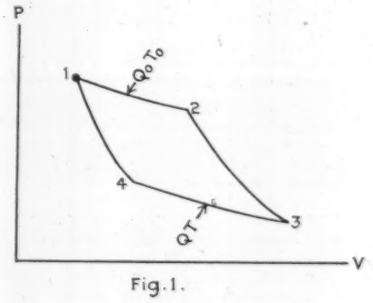


Fig. 1.

Only a part of this external heat is convertible into work through a "heat engine." Owing to the practical impossibility of lowering the temperature of a working substance to the absolute zero, a certain amount of this heat must go to waste, and this waste cannot be avoided by using any possible design of engine or employing any working substance whatsoever.

According to the generally accepted Carnot principle, if a certain amount of heat Q can be absorbed by the medium at an absolute temperature T and the waste heat can be rejected at a lower temperature T_o then the maximum work which can be obtained from the heat Q is equal to

$$\frac{T-T_o}{T}\,Q.$$

The minimum waste possible must therefore be

$$Q-\frac{T-T_o}{T}\,Q, \text{ or } \frac{T_o}{T}\,Q.$$

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If a certain amount of external heat Q is available for the production of work, if a working substance has been selected which has the common characteristic of getting hotter as it absorbs heat during certain changes of state and if all waste heat may be rejected at a temperature T_o, then at any instant during the time that the medium is absorbing this heat a little of it (equal to an infinitesimal at the limit) is absorbed at a practically constant temperature T. Then, of that small amount of heat, dQ, the part $\frac{T_o}{T}\,dQ$ is the unavoidable waste, and the total unavoidable waste for the total heat Q is equal to the summation of all these elements of waste. Representing this total waste by L, it follows that

$$L=\int_0^Q \frac{T_o}{T}\,dQ = T_o\int_0^Q \frac{dQ}{T} \quad \text{or} \quad \int_0^Q \frac{dQ}{T}=\frac{L}{T_o}$$

Now

$$\int_0^Q \frac{dQ}{T}$$

is the mathematical expression called "entropy." Hence from the mathematical equation just deduced it follows that entropy is the minimum unavoidable heat waste per degree of the absolute temperature at which this waste heat is rejected by the working substance.

Is the definition of entropy given above applicable to phenomena like refrigeration where the temperature at rejection is higher than the temperature at absorption? Noting that waste heat and heat rejected are equivalent terms, and considering a simple Carnot cycle like Fig. 1, if the heat Q_o is absorbed along the isothermal 1-2 and the heat Q is rejected along the isothermal 3-4 then according to the Carnot principle the work done is equal to

$$\frac{T_o-T}{T_o}\,Q_o.$$

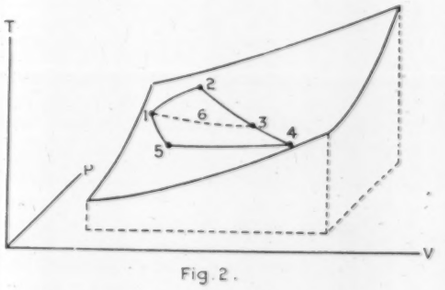

Fig. 2.

If the reverse process takes place—that is, the heat Q is absorbed along the isothermal 4-3 and the heat Q_o is rejected along the isothermal 2-1 then the work which must be done on the working substance will also equal

$$\frac{T_o-T}{T_o}\,Q_o.$$

According to the first law of thermodynamics,

$$Q_o = Q + W = Q + \frac{T_o-T}{T_o}\,Q_o$$

or

$$Q_o = \frac{Q}{1-\dfrac{T_o-T}{T_o}} = \frac{T_o}{T}\,Q$$

where Q_o is the heat discharged at the upper temperature T_o.

Employ the same working medium as before and assume that as the heat Q is absorbed the temperature rises, but that all heat is rejected at uniform temperature, T_o. The minimum heat rejected for each small amount of heat dQ ab-

sorbed must, according to the above formula, be equal to

$$\frac{T_o}{T}\,dQ,$$

and the total heat rejected must therefore equal

$$\int_0^Q \frac{T_o}{T}\,dQ$$

or

$$T_o\int_0^Q \frac{dQ}{T}.$$

Since no cycle can be more efficient than the Carnot cycle (and the cycle contemplated in this case must be a compound Carnot cycle to fulfil the conditions) it follows that the least possible work has been done in rejecting the heat Q at the temperature T_o, and that therefore the least possible amount of heat which can be rejected at the temperature T_o is as in the first case, equal to

$$T_o\int_0^Q \frac{dQ}{T}.$$

Hence the definition of entropy previously given is perfectly general and holds for any positive value of the temperature at rejection whether the heat has been absorbed at higher or lower temperatures.

An important thermodynamic law is that entropy remains unchanged when a substance alters its state adiabatically. It is of interest to prove this. Assume that a certain amount of heat Q is available for the production of work and that in the process of converting this heat into work the physical state of the medium is represented graphically upon the surface, Fig. 2, the coordinates of which are pressure, volume and temperature.

From 1 to 2, the substance absorbs the heat Q; from 2 to 4 it expands adiabatically; from 4 to 5 it rejects heat at the temperature T_o, and from 5 to 1 it is compressed adiabatically to its initial state. The cycle is, of course, assumed a reversible one. Of the heat Q which has been absorbed along 1-2, the total unavoidable waste is, according to the mathematical expression previously deduced, equal to

$$T_o\int_0^Q \frac{dQ}{T}.$$

Since no heat has been rejected along the path 1-2 the working substance at 2 must contain all of this waste heat within it as part of its intrinsic energy. Now let the substance expand adiabatically to 3. Since in adiabatic expansion all the decrease in intrinsic energy goes into external work, the intrinsic energy of the substance at 3 must also include the same amount of waste heat as at 2, and hence the entropy at 3 equals the entropy at 2. Then to say that entropy is unchanged along at adiabatic is equivalent to saying that no heat is rejected along an adiabatic.

Since a substance which has reached a certain physical state along one "path" is in nowise different from the same substance in the same state obtained along some other "path," we must naturally conclude that this definite amount of unavoidable waste within it is also independent of the path. But the entropy for the state 3, or

$$\int_0^Q \frac{dQ}{T},$$

has been obtained by integrating along the path 1-2-3. It must therefore follow that the entropy for the state 3 along any path as 1-6-3 is the same, which is another well established law of thermodynamics. (The term "any path" is, of course, limited to such cases where all of the heat absorbed goes to change the physical state of the working substance; for, if any of this heat is rejected to another substance during the change of state, as by conduction or radiation, this particular amount of heat does not produce any ultimate effect on the working substance and cannot be included.)

Let us consider that part of the cycle from the state 3 to the initial state 1. A certain definite amount of heat equal to

$$T_o\int_0^Q \frac{dQ}{T}$$

and contained within the working substance at 3 is not convertible into work and must be rejected before the initial state 1 can be regained; and since the amount of this heat is not dependent on the previous history of the working substance, as has just been shown, we may make one important deduction: In "thermally degrading" a substance from one state to another to produce work out of the internal energy liberated, the minimum waste is equal to the product of the entropy of the heat required to restore the substance to its initial state along any path into the absolute temperature at which this heat may be rejected.

Two related definitions of entropy have now been developed: one, as the relative unavoidable waste of heat external to a working substance; the other, as the relative unavoidable waste of the intrinsic energy of a working substance. Both are included in the following general definition:

In the conversion of heat into work, whether of heat external to a working substance or contained within it as intrinsic energy, entropy is the minimum unavoidable waste per degree of the absolute temperature at which all of this waste may be rejected by the working substance.

If we regard entropy as relative heat waste, an absolute zero for entropy is as meaningless as for any other relative quantity. Taking entropy as expressed by

$$\int_0^Q \frac{dQ}{T}$$

it can only equal zero when $dQ = 0$, that is when no heat is added as along an adiabatic, or when $T = \infty$, which is impossible.

Since heat waste is nevertheless heat, the unit of entropy is one heat unit per degree of temperature; as, 1 B. T. U. per degree Fahrenheit; 1 calorie per degree Centigrade, etc.

Since entropy is a consequence of the thermodynamic efficiency of a perfect engine, numerical results based on entropy cannot be actually realized any more than the perfect engine can be realized; but, nevertheless, they serve the invaluable purpose of pointing out how near to the goal of perfection man has been able to approach.

As examples of the direct application of the conception of entropy herein presented to the solution of important problems in steam engineering the following are appended. The data are taken from Peabody's Steam Tables.

1. What is the maximum thermodynamic efficiency possible by employing dry steam at 150 lbs. abs. evaporated from hot-well temperature and exhausted against a pressure of 2 lbs. abs.?

Temperature corresponding to 2 lbs. abs... 126.3° F.
Absolute temp. corresponding to 2 lbs. abs. 585.8° F.
Entropy from water at 126.3° F. to dry steam at 150 lbs. abs..... 1.3916
Heat required from water at 126.3° F. to dry steam at 150 lbs. abs.....1,096.9 B.T.U.
Minimum waste, equal to entropy × exhaust temperature = 1.3916×585.8 = 815.2 B.T.U.

Diff., or total max. work per pound..... 281.7 B.T.U.

Maximum efficiency = $\frac{281.7}{1,096.9}$ = 25.7%

Minimum steam consumption per I.H.P. hr. (1 I.H.P. hr. = 2,545 B.T.U.) = $\frac{2,545}{281.7}$ = 9.04 lbs.

2. What is the theoretical gain in efficiency by superheating this steam 100° F.?

Entropy for dry steam, as above.....
Entropy for superheating 100°
$= C_p \log_e \frac{T_1}{T_2} = .569 \log_e \frac{917.8}{817.8} =$
Total entropy for superheated steam.....
Heat required for dry steam, as above....1,096.9 T.U.
Heat required to superheat 100°..... 56 T.U.

Total heat required for superheated steam..1,153 T.U.
Minimum waste = 1.457×585.8 = 853 T.U.

Diff., or total max. work per pound..... 300 T.U.

Maximum efficiency = $\frac{300.3}{1,153.8}$ = 26.0%

Theoretical gain in efficiency = 26.0 − 25.7 = 0.3%

3. What is the maximum work possible by degrading dry steam at 150 lbs. abs. to water at 126.3° F.?

Absolute temp. corresponding to 126.3°..... 585.8
Entropy from water at 126.3° to dry steam at 150 lbs. abs..... 1.39
Diff. of intrinsic energy between water at 126.3° and water at temp. corresponding to 150 lbs. abs. (appr. equal to heat of liquid) ..... 235.2 T.U.
Heat equivalent of internal work for evaporation ..... 778.2 B.T.U.

Total internal energy available.....1,013.7 B.T.U.
Minimum waste = 1.3916×585.8..... 815.2 B.T.U.

Diff., or total max. work per pound..... 198.5 B.T.U.
Minimum steam consumption per I. HP.-hr. =
$\frac{2545}{198.5} = 12.8$ lbs.

An Instance of Corrosion of Structural Steelwork.

By DEWITT C. WEBB,* M. Am. Soc. C. E.

The Steam Engineering Machine Shop at the U. S. Naval Station, Key West, Fla, is a one-story, steel-framed, brick building about 60 × 140 ft. in plan, completed in the summer of 1899. The steel columns of this building are composed of two 12-in., 25-lb. channels, 10-in. apart and latticed. At the corners of the shop these columns are completely enclosed by and filled with the brick work. The intermediate columns are not enclosed on the inside nor filled.

The brick were laid with mortar composed of one part Rosendale cement and two parts sand, mixed together with sea water. Walls were laid close around all steelwork and spaces between brick and steel were well filled with mortar.

In March, 1901, vertical cracks were noticed in the pilasters at the corners of the shop. These cracks first appeared in the centers of the pilasters at about mid-height and gradually extended up and down. In April, 1902, one of the corner pilasters was opened and the steel column, where in contact with the mortar, was found to be badly rusted. The same condition was found to exist at all the corners and they were torn out and rebuilt, the brickwork in rebuilding being kept ½-in. from the steel. No further trouble has been experienced with the corners but cracks have appeared in many of the intermediate pilasters and six of these have been rebuilt. A recent examination of a portion of one of the columns enclosed by the original brickwork showed the steel considerably rusted at all points where the mortar was in contact while adjoining areas not touched by mortar were entirely free from rust.

FELLING TREES WITH A HOT WIRE.—A Berlin inventor, Mr. Hugo Gantke, has recently designed a simple device for the felling of trees. The trunks are cut by the friction of a steel wire about one millimeter in diameter, which, as demonstrated by practical tests, is able to cut through a tree of about 20 ins. (50 cm.) in thickness in six minutes. The wire, which is carried to and fro by an electric motor, is heated by friction on the tree to such an extent as to burn through the timber, the result being a cut which is both smoother and cleaner than that effected by a saw. The wire will work satisfactorily on the thickest trees without the insertion of wedges into the cut, and the trees may be cut immediately above or below the ground. In the latter case the stump may be left safely in the soil.

The motor which actuates the wire is installed outside of the range affected by the fall of the tree, and when electricity is not already available it can be generated by a transportable power plant consisting of a 10-HP. petrol motor and dynamo, which are left at the entrance to the forest during the felling operations.—From a Berlin despatch in the London "Times." Engineering Supplement, Aug. 10.

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The "Interval" Method of Determining Elevations in Stadia Surveys.

By ADOLPH F. MEYER.*

In Engineering News April 28, 1910, p. 483, appeared an article by Mr. E. M. Douglas, of the U. S. Geological Survey, containing a description of the "stepping" (or "interval," as the present writer terms it) method of securing the elevation of objects sighted at on stadia surveys. This is the first reference to the method which the writer has seen in print and he believes it possesses unrecognized worth and applicability, hence the following discussion.

The name "interval" is used to designate the method because the term is believed to be significant. In measuring the distance of a topographic point from the instrument, on stadia surveys, the space or *interval* between extreme crosswires as seen projected against the stadia board, is read. This stadia *interval* is then multiplied by the *interval factor* for that particular instrument, to reduce it to distance. The same *interval*, recorded as "stadia," is used in determining elevations as explained later, and hence the method termed the "Interval Method."

No doubt many transitmen frequently read "upper hair" or "lower hair" and occasionally turn an interval or two, but it is believed that the present status of the method is in most hands distinctly that of an "emergency measure." The method is being extensively used, by the writer, with splendid results on the Minnesota River Survey, covering about 300 sq. mi. of topography with approximately 175 "shots" per sq. mi. Out of 3,038 consecutive shots, for example, 50.8% contained intervals, 6.6% contained vertical angles, and 42.6% were level sights. The average number of intervals per shot was 2.35.

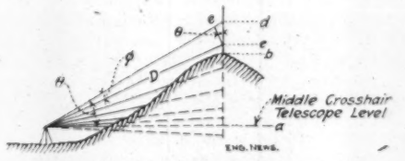

Fig. 1. Diagram Illustrating Method of Determining Elevation by Multiplication of the Stadia Interval.

In determining the elevation of an object above or below the instrument, by the interval method, the stadia reading or interval is laid off against any visible background by means of the tangent screw on the vertical arm until the rod becomes visible. Multiplying the number of intervals laid off by their value in feet as read on the stadia, gives their "rod equivalent," and subtracting (when turning up, or adding when turning down) the rod reading from the rod equivalent gives the difference of elevation between the instrument and the object sighted at. In the accompanying diagram illustrating the method (Fig. 1): First set telescope level and note some point in the landscape on line of middle cross-hair at a; then, raise telescope so that lower cross-hair covers this point. Then, raise telescope successively through the stadia interval (by placing lower cross-hair on point previously occupied by upper hair) until upper hair is on the rod. The elevation of the point on which the rod rests above height of instrument will be equal to stadia interval × No. of repetitions — reading on rod.

In Fig. 1

ab = difference of elevation between height of instrument and object sighted at.

bc = reading of upper cross wire on rod after four intervals have been turned up.

cd = stadia reading or interval on rod between extreme cross wires.

$\phi = 0° - 34' - 23''$ for instrument having an interval factor of 100.

$\theta = 5\ \phi = 2° - 51' - 55''$.

Distance "D" = (practically) 100 cd cos θ.

$ab = D \sin(\theta - \phi) - bc$.

Note.—It is not intended to convey the impression in the diagram, that the stadia interval will be read in *exactly* the position of the fifth interval, but only in *approximately* that position.

Inasmuch as the stadia interval cd on an inclined sight is too large, the rod equivalent of four intervals, namely 4 cd, will exceed ac. The accompanying curve (Fig. 2) gives the correction to be applied to the rod equivalent in per cent. of itself, for readings up to 11 intervals. This curve (the full line) is the graph of the following equation:

$$\text{Correction in per cent.} = 100\left[\frac{N\,cd - D\sin(\theta-\phi)}{N\,cd}\right]$$

where N = number of intervals read.

In practice this correction is usually unnecessary up to about three intervals, hence the following approximate rule: *When more than three intervals are read reduce their rod equivalent by 0.1% of itself for each interval above three.* The correction need only be applied to back and foresights on the main traverse line and can be made mentally. Nine intervals, approximately 5°, is about the run of the average slow motion screw on the vertical arm and the practical limit to the number of intervals that can be rapidly laid off, although it is possible to read more than twice that number with considerable accuracy.

From the accompanying page of field notes (Fig. 3), the method of recording and reducing the readings taken in the field is apparent. The use of signs with all the quantities is a great help toward correct reductions. The height of instrument is carried along so that the vertical angle pointings can be made to any foot of the rod that is visible, and the difference of elevation always refers to the height of instrument and not to the hub beneath it.

Interval readings are preferable to vertical angle readings for the following reasons: They are far more accurate, as a rule are more rapidly taken and greatly facilitate the reduction of notes and the sketching of topography in the field.

Interval readings are more accurate because the telescope bubble, which controls the readings, is about four times as sensitive as the plate bubbles which virtually control the vertical angle readings. Moreover, the plate bubbles are usually in poor adjustment. But even when in perfect adjustment, sun and wind frequently cause them to run off center in a few minutes so that by the time the instrument has been revolved and the foresight read it is not unusual to find them a half division or more off. Although the vernier on the vertical circle may be adjustable by means of a slow motion screw (which has serious objections) so that the telescope bubble may be made to control the vertical angle reading, by adjustment at each sight, the ordinary vertical circle is graduated to single minutes only, involving the possibility of an error of about half a minute in the angle reading—30″ arc is worth 0.3 ft. in elevation at 1,000 ft. The writer's experience with the interval method warrants the conclusion that the elevation of very few stadia stations 1,000 ft. apart, where interval

Page 224 Transit K & E 721 Obs. Jewell Line Azimuth Traverse from △26,
Date 5/16/10 Rain till 10 A.M. Rec. Smith Morton Camp, up Left Bank of Riv.

VALUABLE RETURN TO United States Engineer Office, St. Paul, Minn.

OBJECT	Azimuth	Stadia	Distance	Intervals or Ver. Angle: Up + Down −	No. of Int. or Angle	Rod Equiv.	Read. on Rod	Diff. of Elev.	Elevation above Datum
At △26 Near Road	Dec. 9°-10′			H.I = 897.53					498 892.55
△25 In Pasture	76°-0′	5.84	580						
⊙J417 Edge Cult. - Pasture	42°-7′	447	444	−	½	-2.23	-13.12	-15.35	882.18
At ⊙J417	Dec. 9°-10′			H.I = 886.95					478 882.17 496
△26	222°-7′	447	444	+	2	+18.94	-3.32	+5.62	892.55 493
⊙J418 Near E & W Post Fence	53°-20′	10.58	1051	−	1	-10.58	-14.00	-24.58	862.37
I School House Flag Staff	329°-31′								
2ª Road, Foot of Bluff	130°-45′	2.43	242	+	5° 53′	+24.6	-3.0	+21.6	908.5
3ª Top of Bluff	124°-0′	6.75	670	+	10°-6′	+113.0	-6.0	+107.0	993.9
4ª Line Fence	62°-45′	10.90	1082	−	½	-5.4	-13.0	-18.4	868.5
5ª Road	85°-0′	6.70	665	+	3	+20.1	-1.90	+18.2	905.1
6ª Line Fence	47°-15′	11.40	1132	−	2	-22.8	-8.9	-31.7	855.2
At ⊙J418	Dec. 9°-10′			H.I = 867.16					473 862.43 710
⊙J417	233°-20′	10.58	1051	+	2	+21.16	-6.22	+14.94	882.17 713
⊙J419 Ft. Slope Edge Cult.	73°-54′	11.50	1142	−	½	-5.75	-12.81	-18.55	848.61

FIG. 3. TYPICAL PAGE OF STADIA NOTES IN INTERVAL METHOD.

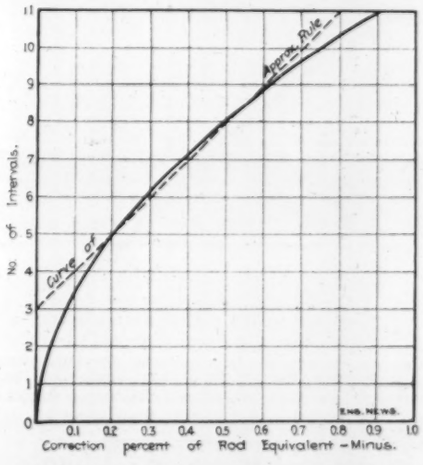

Fig. 2. Curve Giving Correction for Interval Readings.

Distance between hubs.	Diff. of Elev.	Error of mean back and foresight readings. Intervals. ft.	Error of mean back and foresight readings. Vertical angle. ft.	Maximum error of single reading. Intervals. ft.	Maximum error of single reading. Vertical angle. ft.	Minimum error of single reading. Intervals. ft.	Minimum error of single reading. Vertical angle. ft.
†1,160	63.41	−.06	−.14	−.11	−.29	−.01	+.01
1,308	23.88	+.01	+.13	+.04	+.27	−.01	−.02
1,010	65.03	+.01	−.49	±.03	*−.63	00	−.43
†1,213	78.81	+.05	−.38	+.08	−.43	+.01	−.31

*A 30″ arc plus a bubble run of one-half division on the instrument used represents 0.58 ft. A brisk wind was blowing and the plate bubbles had moved off center before the readings had been completed.

†The background against which the intervals were laid off consisted of newly cultivated land, a grassy hillside and waving tree tops varying from 150 ft. to half a mile distant from the instrument.

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readings are taken both forward and back and averaged, will be in error more than 0.08 ft.

The tabulated results on p. 231 are representative of the greater accuracy and uniformity of elevations determined by the interval method. Vertical angle pointings were made at the 3-ft. and 12-ft. mark on the rod at each sight and intervals were repeated.

Intervals may be laid off, with little loss of accuracy, by pointing at desirable background in any direction, so long as the telescope is first leveled on line and the work done with reasonable dispatch.

Aside from their greater accuracy and uniformity, interval readings are preferable to vertical angle readings because, as a rule, the results can be obtained faster and with less effort in field and office. Vertical circles are inconveniently located, generally uncovered and hence tarnished and hard to read, always necessitating the use of a glass. Their reduction involves the use of tables and long multiplications or a slide rule, which it is impracticable to carry in the field. Two or three intervals, on the other hand, usually representing a rod equivalent of 30 to 40 ft., are easily laid off against almost any background. Their reduction involves only a simple multiplication which is permanently recorded, in the notes, as made. The height of instrument is always known and the elevation of any desired side shots readily computed in the field, thus greatly facilitating the sketching of topography.

The writer believes that when once the advantages of the interval method are fully appreciated by transitmen, the use of vertical angles will be restricted to that small proportion of sights taken on an inclination greater than about 5°.

Fig. 1. A Mosquito-Extermination Main Drainage Ditch.
(Dug on the Jersey City marshes in 1907; 20 ins. wide and 2,000 ft. long.)

The Modern Mosquito Extermination Campaign.

By PROF. JOHN B. SMITH,* Sc. D.

Plagues of many kinds have been known to afflict mankind so far back as written records extend and, until within the last century or two, they were accepted as unavoidable and inevitable. They were regarded as either manifestations of divine displeasure or as afflictions meant to chasten those upon whom they were imposed. The treatment was always theological and varied widely; from mere invocation to sacrifices of various description, meant to appease a wrathful or offended deity. With advancing knowledge the method of treatment for many kinds of plagues changed, and one after the other they were lost to the church and transferred to the scientist. With all these various examples of conquered plagues before us, there are nevertheless many others still existing, and every time one of these is attacked there is identically the same chorus of disbelief as to the possibility of victory.

It is not so many years ago that it was first seriously suggested that the mosquito pest might be controlled. The suggestion was met with ridicule and disbelief, even in the ranks of men from whom, by reason of education and training, better things might have been expected.

When the responsibility for transmitting malaria, yellow fever and certain other diseases was once definitely fixed upon certain mosquito species, another powerful body, the sanitarians, was enlisted in the campaign, and gradually the ridicule died out. The disbelief still persists in many places, and chiefly because the factors of the problem are not really understood by the public at large. There is plenty of excuse for that, for it is less than a decade since even the entomologist began to understand them. Up to 1900 only a few species of mosquitoes were known, and it was assumed that they all had the same general life history. It was not until I began the systematic study of the New Jersey problem, in 1900, that the reasons for the failure of earlier efforts began to be evident.

It was found that instead of a few, there were many species of mosquitoes: instead of great uniformity, there was a great diversity in life history; instead of being home-bodies, some forms were great travelers, and that a locality might be almost unbearably afflicted without breeding a single specimen. One fact remained to us, and that is a vitally important one. Mosquitoes develop only in water; it may be salt or fresh, clean or foul, in motion or stagnant; but there must be water in which the larval life can be passed. There need not necessarily be water when the eggs are laid, for many species lay them in mud or in damp places that are only seasonably or occasionally covered, and such eggs may lie dormant for two, three or perhaps more years; but development never takes place until water comes.

Another vitally important fact brought out by my investigation was, that two species bred abundantly only on salt marshes along our coast, and that both these species were migrants, flying as far inland as 40 miles under favorable conditions. Furthermore, that there might be from six to eight broods annually on these marshes, out of water ranging from pure salt tide to rain fresh. In New Jersey alone there are over 290,000 acres of salt marsh, and over half of that is or until recently has been, mosquito breeding ground. My work demonstrated that over 90% of the pestiferous specimens in the state were the salt marsh species, and the importance dealing with that area became at once man

Early mosquito campaigns consisted chiefly getting rid of local stagnant pools and co large swampy areas with oil—effective within its range, but out of the question in covering a state. When the entomologist worked out all the factors dealing with the cycle and habits of the species, it became a problem for the engineer and, since there was other available, the writer turned into a indifferent engineer in working out the pr as it appealed to him. Chiefly it was the marsh problem that was attacked, because

Fig. 2. Bog Saws Used in Ditching for Mosquito Extermination.

were the 90% that were to be gotten rid of as soon as possible.

Theoretically, the matter is simple enough. An ordinary salt marsh is almost level; is porous, so that water runs out easily; and outlets to tidewater are usually within convenient reach. Experiment and observation proved that large ditches were not needed; but that, to be effective, ditches must be deep, straight and with even sides and bottom (see Fig. 1). The final outcome was a trench 10 ins. wide and 30 ins. deep, wherever the character of the ground would stand it. At first shovels and spades were used in the digging work; but the results were not good and the cost was great. Then a modified hay knife or bog saw (Fig. 2) was used to cut the sides of the ditches, and the intervening sods were taken out with hooks and spades. This was much better and cheaper; but not sufficiently rapid. Two of the contractors invented spades, especially adapted to this type of ditching, by means of which a sod 10 ins. wide, 30 ins. deep and 6 to 8 ins. long was taken out at each plunge. With such spades a gang of two or three men could run out from 600 to 800 ft. of perfect ditching in an eight-hour day. (See Figs. 3 and 4, for one of these spades.)

Finally, from a model patented many years ago by a Massachusetts man, a power ditcher was

Fig. 3. The Spade Above Ground.

Fig. 4. In Use for Double-Width Ditch.

FIGS. 3 AND 4. THE MONAHAN DITCHING SPADE; USED ON SECAUCUS MEADOWS, APRIL, 1908.

*Entomologist, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

produced, with which a crew of five men can dig 4,000 ft. of ditch in an eight-hour day, and the cost was reduced to about 2 cts. per running foot (see Fig. 5). This machine runs on planks over the marsh, and the cutting knife is at the back, so that the body is always ahead of the ditch. The essential point is a plunging knife forming three sides of an oblong, the fourth or open side behind. This knife has the sides 12 ins. long, the front 10 ins. wide, is firmly attached to a sliding frame which, in turn, is suspended from the end of a long, powerful lever beam. This beam is slotted and in this slot runs a pin attached to one of the spokes of a heavy driving wheel. As this wheel revolves, actuated by a 12-HP. gasoline engine, the lever beam is alternately depressed and lifted, forcing the knife deep into the marsh and lifting it out again. At the low point of the depression a swinging knife comes into play, cuts under the sod at the depth of 30 ins. and remains to serve as a bottom to the knife until it is lifted clear of the ditch. The sod is hooked off by an attendant who draws it to one side and is kept fully employed when the machine is smoothly at work. With each plunge of the knife the machine moves forward 1 ft., so that sods of even size, 10 × 12 × 30 ins., are taken out and laid in an even row alongside the ditch.

Up to the present time some 25,192 acres of salt marsh have been drained in New Jersey, by 3,-

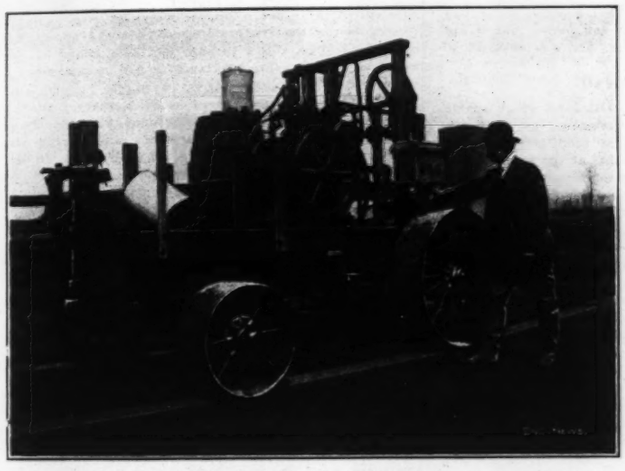

FIG. 5. POWER DITCHING MACHINE: LATEST TYPE OF IMPROVED APPARATUS FOR USE IN EXTERMINATING MOSQUITOES.

464,974 ft. of ditches, and the work has demonstrated its effectiveness. This drainage is only sufficient to remove surface water fast enough to prevent mosquito breeding; but it results, incidentally, in a great improvement in the character of the marsh and the amount of hay produced on it.

The work now being carried on in New Jersey is along a carefully prepared plan; but at present, so far as the state is concerned, covers only the salt-marsh or migrating forms. The local breeders are considered as coming under the jurisdiction of the municipality where they are found and only suggestions and advice are given. The entire marsh area of the state has been carefully looked over, the indicated drainage scheme has been roughly laid down on tracings from the State Geological Survey Maps. The cost of carrying out the scheme was put at $350,000. The law gives authority for the expenditure of that sum; but only as is each year authorized in the general appropriation bill. Up to the present time $83,-000, or less than one-fourth the total, has been made available, and about $68,000 have been actually spent. It is interesting to note, however, that in spite of the fact that small annual appropriations have made the cost of administration disproportionately large, the total cost of the work, thus far, does not exceed the estimates made for it.

Not all marsh areas are as easily dealt with. Some of them are in pockets among the sand hills, and the turf is too shallow to hold a ditch. In such cases filling must be resorted to where the areas are not too large. This filling has also developed as the result of experience, and solid work is no longer attempted. The low area is first covered with layers of shrubs, seaweed, hay or whatever is most readily available, and then enough sand is shoveled over it all to keep the loose filling in place. The loose projecting twigs and branches serve excellently to hold blowing sand during high winds and storms, and in a year or two a solid fill naturally results.

In larger confined areas where there is no outlet, yet another method—that of draining to a center—is adopted. Areas of that sort are usually very low, and at the lowest point of all, water stands for days and weeks, especially early in the season. Out of such areas come the early spring broods and usually the latest of the season as well. It is easy enough to locate the low point during the summer, and there we dig a pool from 6 to 10 or 15 ft. square, and about 3 ft. deep (Fig. 6). In the center of this pool a large barrel or hogshead is sunk. As the barrel is always below the tide line, its contents never dry out. Ditches, as needed, are drawn to this pool, using the natural drainage lines so far as possible, and then the place is stocked with "killies," the little species of *Fundulus* which run in every creek throughout the marshes. It is surprising how quickly such areas dry out by this method, even after long-continued rains. When the area is flooded, the fish run everywhere and quickly dispose of any wrigglers that appear. As the water goes down the fish and wrigglers retreat with it, and the more concentrated the larvae the easier do they become prey to the fish. In a droughty period the fish retreat to the central poot and finally to the barrel, which never dries out because it is below tideline. Indeed, in most of the barrels thus far sunk, there is a distinct tidal change of level varying from 6 to 12 ins., and it may be that considerable water actually gets away through the sand from these pools.

Some of these drainage pools have now been working for three years without impairment, and none have needed more than a mere looking after to repair accidental blockages. In some places the fish have actually increased in number; in others they have been killed out by frogs, toads and turtles, and the ponds have required restocking. In no case has there been any considerable expenditure to maintain conditions.

Another type of permanent improvement which eliminates mosquito-breeding marshes, is sand filling by dredges. Hundreds of acres have been treated in that way by improvement companies and promoters, and miles of territory have been made available for settlement. No work of this kind has been done under my direction, however.

Inland conditions vary more greatly and require a greater variety of treatment. About cities and towns, the dirty and stagnant water problem is best referred to local boards of health, who should deal with it as other nuisances are dealt with. The matter is not entirely simple, since it also involves the city catch-basins as breeding places; and here the city engineer can aid materially in the selection of a type of basin that offers least chance for breeding.

In woodland areas there are always depressions that are water-filled in early spring, and develops one brood of mosquitoes that hang about until mid-summer. Where such areas are to be dealt with, drainage and filling must be done, and here again a great deal of filling can be very cheaply done, because no solid fill is necessary. Grass, leaves, branches, anything that forms a bed that prevents free water from standing above, will answer the purpose.

Deep cold swamps are not dangerous as breeders and need no treatment; neither do open-water areas exposed to wind currents. But overgrown shallow edges of open swamp areas or ponds are dangerous and must be dealt with. Sometimes merely killing out the vegetation along the edges will answer, as thereby fish will be given a chance to get at any insects that may appear. At others it may be necessary to deepen an infested area or fill it. No two problems are entirely alike here, and each must be dealt with according to its special needs.

The important feature to be brought out is that our mosquito campaigns now-a-days are not so much campaigns against the insect directly, as against the conditions that permit their development. We are not attempting to kill millions of mosquitoes, but merely to remove conditions under which millions of mosquitoes breed—and that is sometimes ridiculously simple. At a popular New Jersey resort where mosquitoes were

Fig. 6. Central-Drainage Pool, Mosquito-Extermination Work in New Jersey.

(A submerged barrel in the center of the pool, below tide level, insures a perennial water-supply for the wriggler-eating fish with which these pools are stocked.)

always very obtrusive, we discovered near a group of hotels and boarding houses, a marsh area of about 1,900 sq. ft., so situated that it was an almost continuous breeder. A careful estimate, based on actual collections and counts, gave a wriggler population of 10,600,000 and during the season we actually observed six broods. There were probably eight; but if we accept even the six, it means that over 90,000,000 mosquitoes had bred out of this one hole during the single season. It cost exactly $35 to eliminate this area permanently.

We do not know, even yet, all the factors of the mosquito problem; but what we do know is sufficient to improve conditions to such an extent that the few remaining pests will be so offensive as to create an imperative demand for complete abolition—and that is quite possible, eventually.

TRACKWAYS ON PAVED ROADS IN SCOTLAND are used occasionally on very steep hills both in town and country. The trackways are formed of blocks of granite of indefinite length, 12 ins. broad and 6 ins. thick. Two parallel lines of blocks are laid on the side of the carriageway and at a surface level corresponding to the level of the stone blocks in the paved road. Trackways of this description are found to be very useful where the hills are steep, and where there is a heavy traffic passing over the road.—From paper by Robert Drummond, County Surveyor, Renfrewshire, Scotland, before the International Road Congress at Brussels, August, 1910.

Street Cleaning and Watering in 20 Great Towns of the United Kingdom.*

By T. H. YABBICOM,† M. Inst. C. E.

The City of London is a too highly specialized unit for its ways to be used in comparison with those of provincial towns, but five of the boroughs in the metropolitan district—Holborn, Islington, Westminster, West Ham and St. Pancras—have been selected as fairly typical of work in central and in suburban boroughs; one connected with the most ancient traditions of the kingdom and one the outgrowth of modern industrial enterprise.

The English towns outside the metropolis selected as representatives of the ordinary methods of street cleaning have been Birkenhead, Birmingham, Bradford, Bristol, Cardiff, Huddersfield, Leeds, Leicester, Liverpool, Manchester, Newcastle-upon-Tyne and Sheffield. In Scotland, Edinburgh and Glasgow, and in Ireland, Belfast, are representatives.

The populations of these cities and boroughs vary from 55,215 in Holborn to 760,357 in Liverpool; some are seaports, others far inland, so that the types are different, producing various methods of procedure. Their importance may, however, be seen from the fact that the average population of the 20 towns is 360,000.

Of the 20 great towns now under consideration, 16 have been able to make definite returns of the mileage of the streets paved with various materials. It has been found that the total length of streets in these 16 towns is about 3,200 miles. Of these, 32% are paved with stone setts [blocks], 3% with wood paving, 5% with various materials (including asphalt), and 60% are still maintained as macadam. Evidently, therefore, the question of cleansing macadam roads is of very great importance.

Of the 20 towns, horse-drawn rotary brushes are used on the streets of 14 of the number to cleanse the macadam roads, the engineers of the other six being of opinion that the mechanical sweeper tends to damage the surface. It is thus seen that the majority are in favor of the rotary brush, but it requires to be applied with very great discretion, and the author gave up the use of these mechanical appliances, after having been strongly in favor of them, on account of their effective action, because the coarse bass of which the brush is composed dragged away the finer particles of the surface if applied heavily. Still it is evident that the concensus of opinion is in favor of their use. Almost invariably they are drawn by horsepower.

Efforts have been made at various times to produce a machine which not only will brush the road, but, at the same time, raise the sweepings into a cart attached to it. At least six towns have given trials to these inventions, but the unanimous opinion is that not one has proved itself quite satisfactory.

It is scarcely necessary to record that in all the great towns the principal streets are cleansed at least once in the twenty-four hours, and still more frequently when necessary; this being independent of the continuous cleansing that will be noticed further on. The amount of traffic and the conditions of the weather must decide what has to be done. The second-class streets are usually swept three times a week. With regard to suburban roads and third-class streets, the practice varies from a daily cleansing in some towns to once a week, only, in others.

Whether the street cleaning is carried out better during the day or night is a point on which the towns are not unanimous; there is much to be said on both sides. During the night there is less interference with the traffic by the machines, and the latter, having a fair way, can act expeditiously. During the day it is possible to exercise some complete supervision. In eight towns the streets are swept during the night, in seven others by day, and in the five others on the list both by day and night.

After the streets have been swept by night or by day, with or without mechanical appliances, it is the practice in the majority of the great towns to employ a number of street orderlies, men or boys, to go continuously through the principal thoroughfares and pick up litter and horse droppings, or, as one city engineer expresses it, "tidying up all day." In the opinion of the author, this process is so important, not only from the point of neatness, but of health, that he was surprised to find one exception. These collections are small in quantity, and are usually placed in hand carts for conveyance to some known point from which they can be removed by a cart. A very ordinary receptacle is a bin, either above ground or sunk below the level of the pavement. Where there is a depot within reasonable distance the contents of the hand carts can be taken there direct.

In each of the 20 great towns under consideration, the labor for cleansing the streets is employed directly by the corporation. In two of the metropolitan boroughs the carting away and disposing of the sweepings is in the hands of contractors, but in every other case the removal is effected by the administration. Of course, the contractors provide their own tips and get rid of the material to their own advantage.

The provision of suitable places of deposit in the neighborhood of crowded cities is an increasingly difficult one year by year. The practice is generally to tip slop in tanks from which the water is allowed to drain; sometimes the residium is taken away for use on land. The sweepings from paved streets have a higher manurial value, and at certain times of the year maintain a ready sale; in fact, the author's experience is that at times the demand for sweepings from wood paving is greater than the supply. When the demand is slack much is given away, or is used as dressing on lands belonging to the municipalities. If it were not for the difficulty of transit, land occupiers would find the sweepings most useful and economical, and of late traction engines are called into use for transporting large quantities into the country. Seaside towns have the advantage of being able to send out the unsaleable portions in barges, and drop them at a point where the tides will not return them. Other towns, having a system of canals, are able economically to send away the sweepings in boats. In some towns the holders of allotment grounds* under the corporation are supplied with all they desire gratuitously.

When the streets are dry the usual practice is for a water cart to precede the brush, otherwise a cloud of dust is raised. This is, of course, more especially the case with the mechanical sweepers, but even the hand broom may make things very unpleasant and unsanitary. Attempts have been made to combine a rotary brush and a water sprinkler in the same machine, various types having been tried by 8 of the 20 towns with different results. The experience of the 5 towns was unsatisfactory; 2 found the combination a great success, while the remaining 1 engineer used a petrol water van and sweeping machine combined, and found that it did its work in a satisfactory manner, but was unsuited to city work.

Snow Removal.

Some towns have local acts of Parliament which enable the police to call upon the householders to clear the snow from off footways in front of their premises, and this is the practice in about one-half of the towns noted. But even in those towns there are many miles of footways outside unoccupied premises, public buildings, places of worship and blank walls; bridges and viaducts where the paths would never be cleared at all if the municipality did not do it. The authorities of the other 10 towns undertake the whole duty. By whomsoever the snow is cleared from the path it finds its way to the road, and then has to be removed at the public expense.

Every town of any importance makes careful and systematic arrangements in advance to deal with a fall of snow if it does come. All towns employ snow plows of one form or another, a very usual pattern being a diagonal board or plate on wheels drawn along by horses and delivering the snow at one side. This is very trying work for horses, and cannot be resorted to unless the snow is newly fallen and before it has been trodden hard. V-shaped plows, propelled by an electric motor car, are in some towns employed to clear the tramway tracks.

Having succeeded in heaping the snow into ridges, the duty follows of removing it from the street as expeditiously as possible, but at times and in some places much difficulty is experienced in getting an adequate supply of horses and carts.

The practice of using salt for the purpose of enabling the snow to be cleared easily and expeditiously is resorted to in many towns, but there the authorities make a sort of apologetic excuse for so doing by stating that the practice is only resorted to in "special cases," or "only on the tramway track," or but "very little used." There is no doubt that the use of salt is objected to by a large section of the public on account of the intense cold produced, resulting in injuries to both man and beast, for which compensation has been awarded against the local authority in some cases. Some superintendents are of opinion that it is not possible to cope with a heavy fall without a liberal use of salt, but other equally important towns have found a way out of the difficulty without the employment of a freezing mixture.

Street Watering.

Street watering, to some extent, is almost a necessity with even the best systems of cleansing which experience has evolved. Of course, the macadam road, with its disintegration under rapid traffic, is the worst source of dust, and determined efforts have been, and are being, made to reduce the dust nuisance. It is not, however, the province of this paper to deal with the various methods which have been tried with varying success in this direction.

Tar in one form or another has been the most favored remedy, and there are probably few towns in England that have not tried experiments with tar-macadam, tar painting and tar spraying. But, however perfect the road surface may be, and unlikely to be disturbed by wheel action, dust will accumulate on it in town from a variety of causes. It is therefore not yet possible to do without "street watering."

In the majority of the 20 towns under consideration, all the important streets and roads are watered as necessary. In Leicester rather less than half the total mileage is regularly watered, and in Newcastle-on-Tyne not one-fourth. In Westminster the practice of watering the entire area is confined to macadamized roads, while those covered with wood and asphalt are merely washed to water in the channels only, where the dust generally collects. Macadam roads that have been treated with tar require a minimum of watering, a slight sprinkling before brushing being all that is necessary, the author's experience having been that the expense of tar treatment is nearly recouped by the saving effected in watering.

As might be expected, various types of watering vans are in use in different towns. These may be divided into the four-wheeled van, holding 480 to 540 (U. S.) gals., and the two-wheeled van, containing 240 to 360 (U. S.) gals. With two exceptions these vans are all drawn by horses, but Westminster and Cardiff employ, in addition, motor vehicles for street watering. Whatever may be the form of the body of the cart containing the water, the method of sprinkling it on the surface is of the first importance. It does not make so much difference on paved streets as on macadamized roads; in the latter as much damage may be done by injudicious watering as would be effected by a thunder shower. The nearer the sprayed water can be made to resemble a gentle shower the better, but it is useless to expect this desired end to be effected by the intelligence of the ordinary driver of a water cart. Several towns use the rotary distributor, scattering the water by centrifugal force. This is very effective on wide streets before the traffic is about, but the appearance of the machine in the distance has been known as the cause of the hasty disappearance of foot passengers into doorways or other safe places of retreat, accompanied by comments the reverse of complimentary. Of the many nozzles that have been designed with the object of dividing the streams of water into a fine spray, the author has found none equal to that designed by Mr. T. Caink, the city engineer of Worcester.

During the past ten years many chemical preparations have been placed on the market with the intention of diminishing the dust nuisance, by binding together the particles on the surface of the road. They generally take the form of a deliquescent salt, which, when dissolved in the water and spread over the road, absorb moisture from the atmosphere and keeps the surface damp. For this purpose sea water was used many years ago. It has been ascertained that 8 of the towns referred to have made no experiments in this direction; the other 12 have done so, but neither is at all enthusiastic about the results. Westrumite, pulvicide, calcium chloride have all been tried, the latter most frequently. The author was anxious to learn the experience of other towns as to whether these chemicals in solution have a detrimental effect on macadam, but although some engineers state that they have ceased to continue their use, it seems that the determination was arrived at more because they did not fulfil expectations than for any injury to the road surface. The author's own experience has been that the salts, especially the calcium chloride, by reason partly of its cheapness, can be used on gradients where tar spraying would not be desirable. The effect, however, does not last long, a heavy shower of rain falling soon after the salt has been spread washing it away, and it cannot tend to preserve the road.

Although street watering is no more than a palliative, very evanescent in its effects, at one time covering the road with thin mud, which half an hour later is blowing about in the form of dust, the former condition condemned by owners of vehicles and the latter the cause of endless complaints from shopkeepers, we have not arrived at a point where we can do away with the water cart, but like most other things in municipal government, it requires using with intelligence and discretion. The vagaries of English weather make the lot of a watering superintendent an anxious one. A wet morning, on which no water cart is sent out, may be succeeded at midday by hot sunshine and a gusty east wind, or the morning may break dry and dusty, with every available watering machine on the roads, to be followed by clouds and rain before noon. Sadly the dripping but useless carts have to return to their quarters.

*From a paper read at the Second International Road Congress, held at Brussels, Belgium, August, 1910.

†City Engineer of Bristol, England.

[*Land divided into small plots for cultivation by residents of cities or towns.—Ed.]

THE DANGERS OF THE COMPARTMENT SYSTEM in general use on European passenger cars are called to public attention in England by a number of recent assaults upon passengers. On Aug. 9 a passenger on the Metropolitan Underground Ry. in London was attacked by a man, supposed to be an escaped lunatic, and severely injured. On the same date a young woman on a Midland Ry. train was assaulted and robbed. Another recent crime was called to mind by the exception, on the same day, of a man who killed another in a train near Newcastle, in an attempted robbery a few months ago.

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The great Western forest fires of the past two weeks seem like grim irony of fate. Hardly has the plea for careful husbanding of our timber resources won a country-wide hearing, when the destruction of the elements threatens to clear the problem off the boards by wiping out the chief remaining forest stands. This month's fires are the worst for many years, if present reports may be credited in full. In loss of life they make a new record, indeed, but this is in the main because such desperate attempts were made to fight the flames hand to hand. But while the casualties make the disaster so much worse, they are hardly a gage of its importance in the records of forest fires. The significant point is that this month's fires, as well as those of a year ago, come upon the nation just at a time when the governmental forest administration has attained to an elaborate working organization, when virtually for the first time the chief areas of extensive forest are under thoroughgoing supervision and management.

It may not be ungracious to recall, too, that within a year or so the Forest Service has published a comparative statement showing marked decrease in the number, and more particularly in the average size, of forest fires in the National reserves. With some play of fancy, we may imagine that the elements are cramming the boast down the throats of those who uttered it. The next statement will be less positive a demonstration of the value of the forest control, to say the least. On the other hand, these calamitous fires are, of course, anything but an argument against forest administration. They only prove that in such vast and important control work the fatal play of chance may put columns of figures to shame, and the consciousness of persistent, intelligent effort must be its own stimulus to continued work.

And one thing before all should be gleaned from the forest ruins: more positive knowledge of the causes of origin of fires, so that efforts at prevention may become more effective. That prevention is the only cure in this matter needs no words, especially after the spectacle of the agonized waiting for rains as the only possible check to the fire advance in the Northwest last week. It has been stated often enough that negligence, wanton disregard of proper care, the ejection of fiery cinders along railways, etc., are partners in blame. But which were the causes in the present instance? Which are the most threatening? Where must the main efforts for reform be applied? Let these things be learned, and the resulting facts spread wide and repeated among all the people; then we may have a chance for improvement. The officials are already at work, it seems, for it is reported that several persons are under arrest for criminal action in setting fires. Let the investigations be continued to bring out all attainable facts, so that the prospect of prevention may be brought within tangible distance.

Many of the largest, most costly and most vital of engineering works are directed against the smallest known objects in nature. As an extreme instance, note the immense water filtration plants which have been built for many cities as a safeguard against infection by the typhoid bacillus, 8,000 of which germs may be placed end to end, or 25,000 side by side, and still occupy a space of only one lineal inch. Far larger in size, yet still tiny, another small object against which the engineer and his works are now being directed is the mosquito, the disseminator of yellow fever and malaria among hundreds of thousands of men, women and children since man occupied the earth.

In our issue of Aug. 11, 1910, we described a dike across the Herring River, at Wellfleet, Mass., designed to again render fit for human use a large area of land which, through the decay of one-time drainage works, had virtually been abandoned to the mosquito. Elsewhere in this issue we have the pleasure of publishing an article from the pen of Prof. John B. Smith, State Entomologist of New Jersey, describing the extensive work undertaken by that State under his direction for the elimination of the mosquito pests which have made large areas of that State almost uninhabitable in summer.

In view of the unusual prevalence of mosquitoes in portions of New Jersey during the present summer, we feel that we almost owe the citizens of that state an apology for publishing an article conveying the idea that the mosquito is actually being eliminated in that section of the country. It may be explained, however, that the work undertaken by the State and Prof. Smith is only partly completed as yet, and, furthermore, that a large part of the work of eliminating the mosquito or even keeping it down within fairly endurable limits must necessarily devolve as a continuous performance upon local boards of health, and also and in particular upon individual householders. The most that can be expected of the State is to drain the large areas of marsh land which are in a measure common territory, and from which large areas may be infested by migratory mosquitoes. Upon the various municipalities devolves the duty of draining smaller and more local breeding places or of seeing that they are either drained or filled by private property owners. Where draining or filling is out of the question, local boards of health must either oil the water of pools and other small breeding places, or see that private property owners do it. In addition, the local authorities must see to it that mosquitoes do not breed in catch basins of combined or storm sewers, nor in the hundreds of dirt pails hung under perforated manhole covers.

Do as much as the state and municipality may, there will still remain much in the way of mosquito prevention to be done by the individual householder. This includes particularly the prevention of all minor breeding places, such as quite small pools (which in very wet seasons may be very small indeed), and particularly accumulations of unscreened rain barrels, cisterns and cesspools, and, last, but not least, the miscellaneous collection of old tin cans and the like which are to be found in portions of even well-to-do towns, and almost invariably in less thriving communities. Within the houses it often happens that mosquitoes breed in water left standing in such unsuspected places as flower vases.

Notwithstanding the fact that the elimination of the various minor breeding places must rest primarily with householders, a considerable part of the duty of inspection and supervision will always rest with the local board of health, to the end that the mosquito nuisance will get no chance, large or small, to perpetuate itself.

It is to be hoped that appropriations will be speedily forthcoming which will enable Professor Smith to complete the work on which he has made so good a beginning and regarding which he writes so interestingly elsewhere in this issue.

Although the International Road Congress, in one of its conclusions, called attention to the disadvantage of macadam for general use in large cities, yet it appears from one of the many interesting papers presented to the Congress (abstracted elsewhere in this issue) that macadam is still largely used in many important cities of England, Scotland and Ireland. Returns from 16 of 20 large towns in the United Kingdom show 60% of all the streets improved with macadam. (Much of this, presumably, has been treated in some degree with tar.)

Contrary to general American practice, as we understand it, macadamized streets in British cities are subjected to frequent and regular cleaning. We might well copy our British brothers in this, as in some other matters pertaining to roads.

While referring our readers to Mr. Yabbicom's interesting paper for details, we may barely mention here some practices common to the 20 cities on which he reports: Rotary machine brooms are used by 14 cities to clean macadam, but six others consider them damaging to macadam; the orderly system of street cleaning (a man or boy constantly at work picking up droppings and litter) is used daily, regardless of whether the main cleaning is done by hand or machine; all 20 cities clean their streets by direct labor, and all but two remove the cleanings in the same way, rather than by contract; more or less street watering is done by all the cities, no matter how clean the streets are kept, and whether or not the street surfaces are tarred.

The author's remarks on the limited sale of sweepings from paved streets and the (apparently) still more general use of these sweepings on land owned by the cities, raises the question whether the street sweepings of American cities could be more often put to agricultural or similar use. Some of our cities, but apparently only a few, do use some of their street sweepings on park lands. Probably this use might be extended with profit. Possibly, as a part of the future conservation of natural resources, we shall yet see a far more general utilization of street cleanings on land—to increase its fertility or improve its mechanical properties, or both. Thus far, it seems, such utilization has been of doubtful economy, but with better organization of the work of collection and of transportation of street cleanings, and with increasing difficulty in finding nearby dumping places, combined with increased need for every pound of even low-grade fertilizer, selected street sweepings may yet command a fair and steady price.

The present and recent devastations of cholera in Southern Russia are regarded with comparative equanimity by the sanitary authorities of this country, due to advances in sanitation and to confidence in our national quarantine system. Yet it was only in 1873 that cholera did gain a foothold in this country, and no longer ago than the serious outbreak of cholera in Hamburg, Germany, in 1892, the people of the United States were greatly exercised over the possibility of a visitation of the scourge here and entered upon no little "cleaning up" as a consequence. This "cleaning up" we may add, although doubtless a distinct gain in other ways, would probably have been of little avail against cholera if it had reached our shores, except in so far as

the sanitary measures adopted related to public water-supplies.

Thus far in the present year (up to Aug. 20) the cholera in Southern Russia numbered a total of over 121,000 cases and 58,000 deaths. In one week alone (Aug. 7-14), nearly 24,000 cases and nearly 11,000 deaths were reported. The next week, and the latest one reported at the time of this writing, showed a falling off of something like one-third in the number of cases and one-fourth in the number of deaths.

Why should Russia still be subject to serious cholera epidemics when the disease may be said to have disappeared, probably for ever, from North America and also from England and most, if not all, the other leading countries of Europe, except Russia? The answer, of course, is that cholera continues in Russia largely through the sanitary backwardness of that country. Probably the ignorance and poverty of the people affected also have much to do with the continued prevalence of the disease, and, in addition, the nearness of Southern Russia to Asia subjects it to continual danger of infection. In India, if we are rightly informed, cholera is still endemic or ever present, as it has probably been for thousands of years. It will probably be a long time before cholera in India will be reduced even to occasional epidemic form, due to the widespread and continuous infection of large areas and populations for many years, combined with the ignorance and superstition of the natives and with various religious and other practices which need not be mentioned here.

In a few years or at least decades hence, typhoid fever ought to be almost, if not quite, as rare in the United States as is cholera today. We cannot expect this happy consummation of the fight which is now being waged against typhoid in the United States until the campaign becomes far more general, intelligent and unremitting than it yet is. Unfortunately, in many sections of the country, including altogether a large percentage of our population, very little effective work is being done locally against typhoid, but with the progress which is being made by state and national agencies and by all the more advanced of our municipalities, we may reasonably expect to see typhoid fever in the United States diminish much more rapidly in the near future than it has in the past—and the diminution in some parts of the country has been very marked indeed in the past 20 years. It will be a long while yet, though, before it can be said of any large American city, as it was recently of some large European city, that a typhoid fever case is so great a rarity that local physicians flock to see it.

It seems to be the fashion with International Congresses to attempt to crystallize the results of their deliberations in a series of formal Resolutions or Final Conclusions. Anyone who has attended a national or even a state convention knows how hard it is to get the members present to agree to any really significant conclusions as to technical matters subject to marked variations in practice as well as in opinion. How much more true this is of an international gathering, representing still greater and more varied differences in opinion and practice, can readily be imagined.

Comments on this general subject were made in the Editorial Correspondence on the recent International Railway Congress at Berne, Switzerland, published in our issue of Aug. 4. The conclusions reached at Berne were characterized as lame and impotent. Perhaps some of our readers will think the same is true of the conclusions reached at the Second International Road Congress, held recently at Brussels. It may be true of some of the Road Congress conclusions, but in general we think our readers will agree, on reading the conclusions elsewhere in this issue, that the most that can be said of them is that some of them state the obvious, others are negative in character, and many contain no more than statements of the need of further investigations.

It is sometimes worth while to agree on and state the obvious, and thus eliminate it from further discussion, as well as emphasize anew old truths not yet generally grasped or lived up to. A negative conclusion may conceivably serve as a guide to or toward a positive one. There is always value in deciding on and emphasizing what demands further study before any conclusions can be drawn—obvious, negative or positive.

It will be seen from a reading of the Brussels conclusions that bituminous materials still hold the center of the world's attention as agents in the continued utility of broken stone as a road material, to take the place of mud and water binders, and of water and various deliquescent salts in solution for keeping down dust on roads that were not made (relatively) dustless by their original composition and mode of construction.

Besides the positive assertion that deliquescent salts and surface treatment with tar, etc., afford only temporary relief from dust, attention may be called to the unequivocal recommendation of "mechanical processes" for use in cleaning and watering streets and to the definite statements of the permissive weights and speeds of motor vehicles which may be used without "abnormal damage" to roads.

Finally, we would call attention to the very readable personal narrative of the Congress and its attendant excursions which precedes the "Conclusions," and which (owing to the illness of the member of our editorial staff who was in Europe for the purpose of attending the Congress) was kindly written for this journal by Mr. E. E. Corthell, M. Am. Soc. C. E.

Having obtained a filtered water-supply and greatly reduced typhoid fever thereby, a movement is now on foot in Philadelphia to secure adequate sanitary inspection of the milk-supply. It appears that the Bureau of Health of the city and the private Bureau of Municipal Research are cooperating in this much-needed work, which, if carried to a successful issue, cannot fail to have a marked effect on reducing the case and death rates from certain communicable diseases and considerable effect upon the general death rate as well.

Invention and Design in Relation to Patents.

It is a trite remark, among others than patent attorneys, that "you can get a patent on anything." The meaning of the phrase appears to be that, whereas the grant of letters-patent asserts the subject-matter to be a new and useful invention, there may actually be serious doubt whether the device or process patented is new, or is useful, or constitutes invention. Possibly it is heresy to feel skeptical concerning the value of patents generally, but that such feelings do exist is evidenced by the remark quoted. Skepticism is expressed even more clearly in another statement almost equally common, namely, that a patent has no force until it has been through the courts.

Abstractly, such a state of affairs is wrong. The grant of a patent should carry with it a very strong presumption that the subject-matter is new and has the character of an invention. The question of utility must in a measure be subject to future application, though even this should be looked to in granting a patent, so far as to exclude trivial matters.

Whatever doubt exists, concerning patents, is not meant to reflect on the Patent Office. The onerous duties of that bureau are fully appreciated, and its performance of those duties under many hampering circumstances receives full credit. The implied charge in all cases lies against the inherent difficulties of the patent situation, and also, no doubt, to some extent against the particular laws under which it is administered.

Fundamentally the patent principle assumes that public interest requires granting protection to those who produce distinctly new creations in the useful arts. The exercise of originality is to be fostered by being rewarded through a monopoly of manufacture or use. But from this principle immediately rises the question: what [illegible] identifying mark of originality? In other [illegible] looking at the product rather than on th[illegible] knowable mental processes which produc[illegible] it, we have to decide what characterizes an i[illegible]ntion.

This question has never received a [illegible]ad categorical answer, in spite of the fact tha[illegible]ur-ing a century of patent administration [illegible]ny able minds have dealt with it. Naturally, [illegible]en, there have been differences and doubts co[illegible]rn-ing the answer made in a specific applicat[illegible] of the question. And just as naturally the P[illegible]nt Office will not seek to draw a sharp line in [illegible]ch a delicate matter, where dozens of learned j[illegible]ges have failed to give a fixed criterion; the [illegible]ffice must inevitably look more toward the [illegible]ord "new" than to the word "invention." I[illegible] a device be new and of such character that it [illegible]an be described exactly and comprehensively, [illegible]nd the recondite question whether it constitute[illegible] an invention must be passed lightly by.

Of course even the mere question of novelty often causes trouble. In so far as a wrong decision results from failure to discover identical constructions of earlier date, it is pure error. The matter is otherwise, however, when (as in perhaps most contentions concerning the novelty of a patented device) the prior device is not identical, nor equally excellent, but represents a slightly different development both in kind and in degree. In this case "novelty" is closely bound up with "invention," and the question must depend largely on the definition given to the latter term.

In our American practice the decision as to novelty lies solely between the applicant and the Patent Office. Their joint conclusion determines the granting of the patent. Other persons may possess information which would oppose the issue of a patent, but they have no opportunity to be heard until, long afterward, the matter comes into court by an infringement suit. Even then they may not be heard, through not being parties to the suit, or having no longer an interest in the subject, or otherwise.

Other countries have provided for an earlier hearing of the pros and cons, by exposing all applications to public inspection and giving opportunity for argument in opposition. Needless to say this hearing is vastly more favorable to full and true presentation of facts than one occurring many years afterward, when much has been forgotten, when it is hard to reconstruct a correct picture of the exact state of the art at the time of the claimed invention, and when commercial developments unrelated to the merits of the invention may have established a fictitious basis for estimating the worth of rival ideas.

The adoption of a similar plan of public examination prior to grant of patent is much to be desired for our country. Its beneficial possibilities in the way of clarifying the status of patents and bringing to light the true state of the art at a given moment are obvious. Possibly it would also tend to minimize those long delays by which patents sometimes are kept in the Office for years before issue, and a monopoly period far larger than the statutory 17 years is obtained.

But the difficulties surrounding the word "novelty" are almost vanishingly small compared with those which spring from the undetermined nature of the word "invention." The trouble here is that while planning or making of any kind always involves creation and originality, it does not always represent invention. A large fraction of all creative work comes about in the ordinary application of trained intelligence, and such work, which we call *design*, is not and should not be given a claim to patent protection.

To illustrate: When an architect plans a house, his product is likely to be different from any existing house. It will have different arrangement of rooms, different external appearance, and greater (or less) attractiveness and convenience in its interior, etc. Yet his house is not classed as a new invention, although the faculty which psychologically speaking we call invention was the source and instrument of the

design. So also the man who sets out to draw plans for a steam-engine, or a wind-mill, will exercise the inventive faculty in his work, and his product will differ from other steam-engines or wind-mills; but it is likely that his machine will not be an invention within the meaning of the patent laws. Similarly, by far the larger part of the work of planning and construction constantly in progress in the world is of that character which we distinguish from patentable invention by saying that it is mere designing.

In the above illustrations the non-patentable character of design was obvious. But in a great number of cases this is not so, and the product of the design is sufficiently characteristic that it can be defined by description, and in that form appears new, i. e., different from anything previously produced. At the same time only the average skill and training was applied to his task by the designer, and nothing was accomplished that another man of equal training, charged with the same task, would not have accomplished about as well.

Those who have noted how many thousands of patents are issued in the United States each year have long entertained doubts as to the average merit of a patent, and as to whether most patents describe real inventions. Surely only few among the multitude can be creations of real inventive novelty, or real utility. We may record here our opinion that if the distinction between invention and design were rigidly maintained, and no patents granted on mere design, the number of patents issued in our country would be enormously decreased. There is little room for doubt that this would prove highly beneficial on the whole, and would nowhere work any substantial injustice.

We have already remarked that no satisfactory definition of invention, to differentiate it from design, has ever been given. The many attempts at a definition all fail either in merely shifting the difficulty or in setting up a subjective criterion, i. e., one looking to the nature of the creative thought or labor. The former is the case when we say that anything distinctly new, either in function or in manner of performing a given function, is invention. Here we have only shifted the difficulty, for we must decide what is a distinctly new function or manner of performing it. Taking machine design as example, the various structural elements as well as the elements of mechanism are all known, and practically all combinations of them are known; yet when a particular motion desired in a machine is provided by certain gears, shafts, levers or cams, it is usually patented so long as no earlier machine of similar type employed just that grouping of parts. A fixed criterion for judging when the combination is "new and useful" enough to be considered new is not at hand, and the decision must therefore be arbitrary, or let us say personal. If we say it is new when the result is surprising, or unexpected, we are no less on a personal basis, for, obviously, what one may not expect another may predict.

The other type of definition looks at the mental process of designer and inventor, and says that invention represents a creative effort of a nature obviously different from the routine character of mere design. It therefore asserts that when a new object is of such kind that its creation involved a distinct forward step of the mind into the unknown, it contains invention; on the other hand it is mere design if only ordinary knowledge and skill, or only the recognized methods of planning employed in the respective art, were required for its production. In the first place, the two halves of this definition are not coordinate; they may therefore conflict. But more important is the fact that such attempt at reasoning back from the invention to the mental process is no less arbitrary and personal than the other distinction. Put it to the test of a particular case and its personal-opinion character will be evident.

A distinction that rests so strongly on a personal basis that two men of equal intelligence may with equal probability apply it in opposite ways is bound to be unsatisfactory in the long run. The uncertainties of patent litigation are known to everyone; they are due mainly to this very fact, namely, that individual opinion as the final arbiter is just as uncertain and erratic as the throw of a coin.

To get around the difficulty an Austrian patent expert recently set up what he claims to be an *objective* definition of invention, that is one which does not depend on personal idiosyncrasy for its application. He founded it on an original course of reasoning, which in some respects is rather attractive. Says he, we must regard the arts and industries (and their applied sciences) as a connected entity of many ramifications but continuously growing, like a tree of many branches. Each branch grows outward at its tip, by invention or equivalent development. The characteristic of invention is that it constitutes a forward growth at the present termination of some branch. The author* summarizes his definition in the following words, as we render them from the German:

> An invention is a technical achievement which prolongs a technical development series beyond the present terminal member, and which, considered as the solution of a set problem, could not have been obtained by means of current knowledge and skill as a known combination of elements employed in a known way, such combination being known either in the respective development series or in one closely related thereto.

He further defines "technical achievement" as being the production of (or design for) a structure, or the specification of a continuous chain of processes, which effects a result having industrial value.

The essential novelty is that this definition directs us to look at the upbuilding of the art to which the invention refers, and to note whether any detail ramification of the art is by it carried beyond the last definite step previously achieved. Of course this is not very different from what has long ago received recognition and appears in every patent description and patent adjudication, where the prior art is set forth, its limitations determined, and the new invention described as a means of passing beyond the existing limit. But the present definition puts this matter into different form and places it in a more commanding position. Its application might help measurably toward reaching more certain results in some patent questions, and (what is of some importance) it would aid in excluding triviality from the patent register.

But let it be noted that under this definition the differentiation between invention and design is still largely made on the basis of a personal view, namely, the opinion whether or not the achievement could be brought about through current knowledge, etc. And with this in mind we are bound to say that the proposed definition would often fail. It must be conceded that, for any production whatever, a suitable prior problem can be found (or invented), and the production be made to appear as the terminal link of a development series; but if this be true it would be necessary to refer to the second part of the definition as a criterion.

We hesitate to use an actual case to illustrate the bearing of definitions on practice. Perhaps even a fictitious illustration will not be wholly useless, however. Suppose, therefore, Smith-Robinson gets the idea that brickbats would be a convenient filtering material for use in sewage filters, and applies for a patent, claiming a filter of increased efficiency. Shall the examiner regard the new combination as prolonging the development series of sewage filtering devices? Shall he say that whereas sewage filters of increased efficiency are a valuable addition to our equipment, therefore Smith-Robinson should have a patent? Shall he decide on the question of whether it is a known combination of elements? [We assume here that no one will have used brickbats in a sewage filter before.] Or shall he attempt to reconstruct Smith-Robinson's mental processes, and say that a real creative effort was required, inasmuch as no one ordinarily would have thought of using brickbats to secure higher efficiency?

The case will be a little different after a patent is granted and an infringement crops up. Brown finds, we will say, in building a certain roughing filter, that brickbats happen to be the cheapest material at that particular location, although large gravel would do as well if it were at hand. He uses brickbats and is sued. Shall the judge award damages and injunction against Brown on the ground that a sewage filter filled with brickbats was not described or in use prior to Smith-Robinson's patent? He may take the view that, given the broad functions of a filter, the detail arrangement and selection of filtering material was a mere matter of design, capable of being determined either excellently or indifferently, but still only design. Or he may say that the conception of a filtering mass of brickbats for sewage filters was meritorious invention because, first, everyone had been engaged in seeking for more efficient filtering materials, but yet Smith-Robinson had been the first to hit upon brickbats, hence he was a prior inventor, and second, Brown's attempt to discredit the invention by alleging its worthlessness is negatived by his use of brickbats in the filter in question.

The point is that sewage filters of higher efficiency do represent a problem standing at the terminal point of a line of technical development. Also, the use of the particular material of increased efficiency, brickbats to wit, is new invention in the sense that mere design from current knowledge could not hit upon any material of increased efficiency. Also, of course, brickbats as a sewage filtering material in combination with suitable container, drains, and sprinkling or flooding devices, represent undeniably [we are assuming] a new combination for effecting a known purpose; or we may say that not only the combination is new but also the function, namely, filtering sewage at high efficiency. All definitions doubtless can be construed to prove Smith-Robinson a real inventor entitled to patent protection. And meanwhile the brickbats may in fact be quite worthless, or they may be no better than gravel, stone or the like; yet the patent is just as valid as if a real advance had been made, as if the world's stock of tools had been measurably bettered.

Such thoroughgoing and hopeless complications, with which the patent situation is entangled at every point, tend to give some countenance to the radical view expressed occasionally, that patent granting should be done away with entirely. It is claimed, to begin with, that invention would proceed as actively without the lure of the Patent Office as now. It is claimed also that greater justice in the distribution of benefits would be secured; that under modern conditions only the large producer can reap benefit from patents—and even his benefits are doubtful, especially when a well-heeled competitor disturbs him with interfering or development patents, or with infringement and claims of priority. It is claimed that the present system actually hinders progress by tying up the utilization of fruitful ideas for a long term of years, without providing any stimulus to progress. But above all, the entanglements and sophistries and vain disputes which arise under the existing patent practice are pointed out, a waste of energy which the abolition of patents would wipe away completely.

Doubtless any such step as abolishing patents is far in the future, if it be ever made. The present trend is toward extension of patent protection rather than curtailment. It is hardly pertinent to refer to the spread of laws requiring working of patents, or maintenance by fees, for these do not bear on the real difficulties of the situation. And on the other hand the extension of protection in the neighboring field of copyright protection indicates the prevailing trend of thought. But there is obviously wide scope for patent reform, in our country first of all. The step toward removing the final adjudication of patents from the ordinary untrained courts is an important beginning. It is no more than a beginning, but perhaps it will clear the ground for further reform. The fundamental doctrines of reform ought to be fixed early in the campaign, and engineers should be the ones to formulate them.

*Josef Löwy, of the Patent Office of Austria-Hungary, in an address before the Oesterreichische Ingenieur und Architekten Verein, Nov. 10, 1909, printed in "Zeitschrift des O. I. & A. V.," 1910, No. 1, pp. 2-4.

LETTERS TO THE EDITOR.

Another Instance of Swelling of Wood Embedded in Concrete.

Sir: In your issue of Aug. 11, 1910, p. 155, Mr. C. G. Rupert tells of bad results on account of wood embedded in concrete. An experience similar to his was met at Hyde Park, Muscogee, Okla., some eight or nine years ago. A pavilion was built in which the columns were single hollow concrete blocks. The builder thought that the columns were weak so he inserted a piece of 4 × 4-in. timber in the columns as a stiffening core. The moisture that penetrated the blocks caused the wood core to swell and burst nearly every block in each column.

Respectfully,
P. R. Van Frank, Jr.

Little Rock, Ark., Aug. 13, 1910.

Laying Cast-Iron Pipe to True Curves by Deflections at the Joints.

Sir: Is it customary, or to any extent practicable, to lay ordinary cast-iron water pipe, bell and spigot pattern, 12-ft. lengths, on true curves?

Under what conditions, if any, would it be allowable and what would be the greatest degree of curvature on which it would be feasible to have same put down?

If any instances are available of pipe being laid in this manner, kindly cite same. Yours truly,
H. McN.

Canada, Aug. 18, 1910.

[According to Turneaure and Russell's "Public Water-Supplies" by "deflecting each length slightly" it is possible "to lay 4 to 8-in. pipe to a curve of 150-ft. radius and a 36-in. pipe to a 500-ft. radius." Brief specific statements of actual experience in this particular would be welcome.—Ed.]

Real Estate and Personalty in Machinery.

Sir: What is the line of demarkation between real estate and personal property as affecting machinery and the mechanical equipment of shops? The term "Fixed Machinery" is often used, meaning that class which is to be rated along with land and buildings as real estate. What kinds of machinery are "fixed"?

I might put my question more specifically, as follows:

(1) Are machine tools, such as lathes, drills, shapers, boring machines, hydraulic presses, steam hammers, pneumatic hammers, shears, punches and the like, real estate or personal property?

(2) Are shafting, jack shafting, belting, sprocket chains and the like, real estate or tangible personal property?

(3) Are steam or gas engines, pumps, generators, motors, feedwater heaters and the like, real estate or personal property?

(4) Are boilers, heating systems, oiling systems, blowers and the like, real estate or personal property?

"A. B."

Aug. 20, 1910.

[Machinery does not subject itself readily to the common distinction between fixed and movable property; yet it is important to have a dividing line definitely fixed. Although machine tools and other items of machinery are often set on masonry foundations, there seems to be no good reason why this should differentiate them from similar machines set directly on the floor. Nor can a distinction between tools and machines be maintained. Portability also is an inadequate defining mark, as for example a foundry drop or breaker may be more easily transported than a large planer, though on the face of it the latter is more certainly "movable property" than the former. We would add to the items listed in the letter above, the items of cranes and conveying machinery. It would not be inconsistent to class a traveling crane as part of the real estate, while including the working machines with personalty. The opinions and experiences of engineers on the subject will be of value; for while the distinction sought is a legal one, yet the facts on which judgment must be based are better known to the engineer.—Ed.]

A Prose Pean to the Technically-Trained Engineer.

Sir: The enclosed clipping from the "Educational" issue of the "Chicago Tribune" of Aug. 4, may interest some of your readers:

To dig the Panama Canal, to bridge Niagara, to build a subway—this is work for men with red blood in their veins, men with imagination and a desire to leave behind them records of work done in enduring stone and eternal mountains, men of whom the world, for great services rendered, gratefully rewards with fame and gold.

A Theodore Shonts, a John Hays Hammond, a Randolph Isham, these are the names embodied in the dreams of the young aspirant for an engineering career. Similar work to that which has made their names and fortunes lies ready waiting for the brain and energy of the graduate of the engineering college. Adventure, the joy of conquering nature, bending nature to the will of man and civilization, the chance for visiting many lands, opportunities for fame and money making, are the rewards of the engineer.

The field for the labors of the engineer—constructive or electrical—are practically unlimited. The student graduating from the accredited technical school is assured of a good position months before he graduates. Indeed, it is a true embarrassment of riches when, as is repeated yearly with the graduating classes of every technical school, the youthful engineer has to choose between several enticing and profitable offers of employment before he has ceased to breathe schoolroom air.

One only, among the multiplied advantages of engineering as a profession compared with the older professions of medicine and the law, is that the young engineer is entirely and comfortably self-supporting from the beginning—earning a good salary from the start. The technical school trained engineer holds the world in his hand. Employers are waiting for him. Opportunities for ultimately becoming independent, his own employer, are legion.

Italy, France, Germany have been the training schools for the world's greatest engineers. The American, trained in American polytechnics, is the world's greatest engineer to-day.

Great eras of commercial and political expansion are the periods when the mightiest feats of engineering are conceived and executed. The greatest days of engineering are still to come in the United States. Not only the United States but the Philippines, Hawaii, Cuba, Alaska, the islands of the sea are calling—Give, give—more engineers, more engineers—technically trained engineers.

Your readers will, of course, be glad to know that "the technical school trained man holds the world in his hand." Yours truly,
F. W. Doolittle.

1446 Jackson Boul., Chicago, Ill., Aug. 17, 1910.

Notes and Queries.

The caption of Fig. 10, p. 203, in Eng. News of Aug. 25, 1910, was incorrectly printed as "Two Thermit Welds on One Spoke of a 24-ft. Fly-Wheel." The caption should be as follows: Thermit Can Attached to Iron Rod, Ready for Use in Foundry Ladle.

A Cave-In Caused by an Underground Stream at Staunton, Va.

By F. B. VAN HORN.*

The scene of the recent cave-in at Staunton, Va., was visited by the writer on Aug. 12, and a description of it, with a discussion of its causes, may prove of interest to geologists and engineers.

About 10 a. m., Aug. 11, the sidewalk on Baldwin St. (see Fig. 1), in front of the fire engine house, began to subside. The sinking was gradual and gave ample time to vacate the premises immediately adjacent to it. It continued until a depression perhaps 50 ft. in diameter and 50 ft. deep had formed. A second cave-in followed to the southwest of the first, and a slightly larger hole resulted, in which a 1½-story frame building was engulfed. On Aug. 12 a third hole still further to the southwest was formed into which portions of two houses fell. A birdseye view of the scene of the three sinks is shown by Fig. 2. The ground separating the sunken areas is cracked and fissured, evidently because of the slumping of its support from below.

The Underground Stream.

Staunton is near the head of a small valley on either side of which are hills of Shenandoah limestone of the Cambro-Silurian age. This valley is an old stream that has been filled to some depth with fresh-water marl and with alluvial wash from the surrounding hills. Springs are numerous along its borders, and during times of heavy precipitation, quantities of water too large to be readily carried by the channel of the small creek that flows through the city sometimes cause small freshets.

The easy solubility of limestone in water that carries carbonic acid gas in solution leads to the formation of the underground channels and caverns so numerous in limestone regions. Such a channel appears to have formed within the limestone underlying a portion of the city of Staunton. The water probably at first followed joint planes in the limestone and gradually enlarged these by solution until at the present time a channel exists that is 4 or 5 ft. wide at points where it may be seen from the surface, and may contain wider chambers and rooms. Its depth is probably more or less irregular but is not accurately known anywhere, although a plumb-bob let down from the engine house showed 11½ ft. of water, with an interval of about 8 ft. between the surface of the water and the roof of the channel. It would appear, therefore, that the channel is about 20 ft. deep at this particular point.

The course of this underground channel is revealed by the line of newly formed sinks, which is northeast-southwest at the points where the caving took place. A photograph (Fig. 4) taken from the second story of the engine house shows the upper portion of the channel with an arch of limestone forming its roof. In the second sink just to the southwest of the first one (Fig 3) no channel could be seen on account of the debris which partially filled the cavity. In the last sink, however, still further to the southwest, the channel is revealed in a line with that in the hole under the engine house, and appears, as shown in the accompanying photograph (Fig. 5), to be of about the same width.

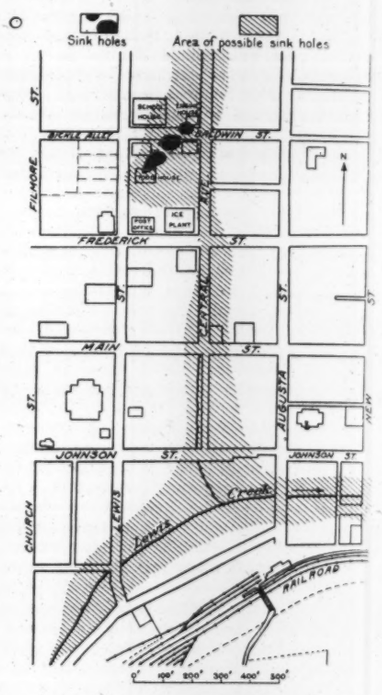


Fig. 1. Map of Portion of Staunton, Va., Showing Sink Holes and Area of Possible Cave-In.

Cause of the Cave-In.

Underground channels in limestone are usually very irregular in their courses. They follow joint planes and lines of easy solubility in the rock and as a result great chambers may be hollowed out at one point, while elsewhere only narrow and often tortuous passages exist. The grade of such a channel is almost equally likely to be irregular, so that its depth beneath the surface may vary widely within short distances.

The channel underlying Staunton appears to be no exception to these rules and the three points where the sinks occurred undoubtedly mark the positions of chambers of some size. During dry periods presumably the only running water in the channel is that contributed by springs and by the soil water which seeps into the limestone from the neighboring hills. At times of heavy rainfall, however, doubtless a relatively large volume of water occupies the channel which presumably has many obscure connections with the surface. Through the constant solvent action of this water on the limestone, the thickness of the roof has gradually lessened until it became too weak to support

*Geologist, U. S. Geological Survey, Washington, D. C.

the weight of the overlying material, when it gave way, resulting in the cave-in. This took place naturally after a period of heavy rainfall, when the overlying soils and marls were saturated and semi-liquid, for at such a time they exert the greatest pressure upon their foundation.

Precautions Against Further Subsidence.

The damage thus far done to buildings is slight on account of the fact that the caving took place on the outskirts of the town. One small frame building was engulfed in one of the sinks, a portion of a brick dwelling fell into another, and the fire engine house which was partially undermined by the third was torn down in order to permit the work of filling to go on. The city authorities have decided to build a concrete arch over the channel at the points where the caving occurred, thus preventing any further sinking, and to fill in the holes with riprap.

Fortunately there were no very large or valuable buildings at the particular points where the sinking took place. Just to the west of the engine house, however, is a large brick schoolhouse, and for a time it was feared that this would be undermined. This building rests on piles driven into the clay and marl. At the west end of the building, the piles struck solid rock at depth of about 15 ft., but at the east end, near the engine house, it is stated that 66 ft. of piling was driven without reaching rock. The city authorities plan to test underground conditions around this building by boring to rock and will take steps to reinforce it if necessary.

A large frame house stands over the edge of the southwesternmost hole. At the time when this sink formed, a portion of the brick foundation of the house fell into it. The cavity extends a short distance under the house so that now a large brick chimney stands just over the channel with only about 4 ft. of earth to support it. At this point during Aug. 12 and 13, the earth was sloughing into the depression at frequent intervals, and it appeared that the house must eventually collapse if measures were not speedily taken for its protection. To meet this situation, a cable was stretched across the hole, a platform was built and let down into it and it was proposed to arch over the channel, place supports under the chimney and then fill up the hole. It was necessary to do this quickly before the ground slumped enough to allow the house to settle into the cavity, and according to recent notices in the local papers it has been successfully accomplished.

The brick postoffice building is approximately in line with the exposed channel, but borings indicate that solid rock underlies this building at a depth of about 25 ft. The Smith Ice Co.'s building rests directly on rock, and a well bored by the company extends 802 ft. into the rock. There is clearly free connection between this well and the sink-holes, for immediately after the cave-in the pumps brought up muddy water, but this connection is doubtless effected through some minor passageway in the rock which permitted the muddy water from the sink to find its way into the well below the casing. The pumping of the well cannot be regarded as in any way the cause of the caving.

The houses on the west side of Lewis St. are built on a shelf of limestone which appears to swing around back of the postoffice and the ice plant and then to turn to the south. It is possible that the underground channel continues on to the southwest into this limestone. If this be the case the roof of the channel is sufficiently thick to prevent any sinking; but it is more probable that the subterranean channel follows the surface valley, and in this event it is possible that other subsidences will take place. The area of possible danger lies within a very narrow strip running through the town as indicated on the sketch map. Just how far the possibility of further subsidence exists can be ascertained by boring into the limestone far enough to indicate whether it is solid or sufficiently thick to sustain the weight above.

According to estimates submitted by General Manager Ashburner of the city, the cost of arching over the channel will be about $5,000, and the cost of filling in the sinks and doing necessary overground work in replacing Baldwin St. will be about $6,000. The damage to buildings has been estimated at about $2,500. Thus, $15,000 is probably a liberal estimate of the total damage.

Geological Status.

The occurrence at Staunton is exactly similar to the process by which many so-called "sink holes" which exist in all areas underlain by limestone are formed—that is, underground waters form caverns in the limestone. These caverns are gradually enlarged, the roof weakens until it is unable to sustain the weight of the overlying material, then collapses and the material above sinks into the cavity.

In this instance a perfectly natural and usual process attracted wide attention only because it took place beneath a densely populated area, where it involved loss of property and endangered life. Had the sinks formed in a thinly settled district their existence might not have been detected for days and would then have been merely a matter of neighborhood news and casual cross-roads' discussion instead of agitating a city and supplying headlines for metropolitan dailies.

FIG. 2. FROM TOP OF POST OFFICE.
(Sink indicated by arrow.)

FIG. 3. LOOKING NORTHEAST TOWARD ENGINE HOUSE.

SECOND OR MIDDLE SINK AT STAUNTON, VA.
(Edges of first sink can be seen in Fig. 4 in front of nearest door of engine house.)

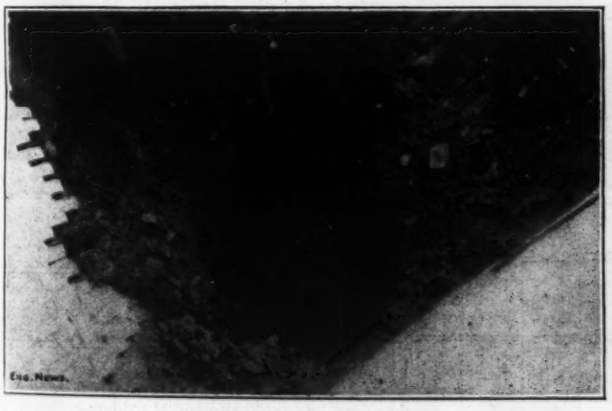


FIG. 4. NORTHEAST SINK FROM SECOND FLOOR OF ENGINE HOUSE.

FIG. 5. SOUTHWEST SINK FROM NORTHEAST EDGE.

NORTHEAST AND SOUTHWEST SINKS AT STAUNTON, VA., SHOWING UNDERGROUND CHANNEL.

A New Form of Rail Connection for Drawbridges.

Rail locking and unlocking arrangements, made necessary at the ends of drawbridges by the requirement of maintaining a close and smooth joint in the track when the bridge is closed and disengaging the rails when the bridge is to be opened, have been produced in various forms. The most common, doubtless, is the lift-rail arrangement. In this the terminal length of rail on the bridge is fastened to the ties at its rear end only, while its forward portion rests on flanged bed-plates and the joint end is seated in a pocket formed by blocks or plates fastened to the end of the abutting fixed rail; this forward end of the lift rail can be lifted out of the pocket, high enough to clear the top of the fixed rail as the bridge is swung. Suitable levers and lift rods are provided to raise the rail out of the pocket and to drop it back into place (or, more properly, pull it down into place by positive connection). In lifting, the rail yields partly by bending, partly by rocking on its rear edge, for which latter purpose the spikes holding down the rear part of the rail are usually driven only part way.

Lift-rail arrangements are sometimes built with miter joint of the rail, sometimes with square (butt) joint. In the latter the necessity for reducing the pounding of wheels requires a tread-block along the outer edge of the rail-head to carry passing wheels over the joint. This is specially necessary because temperature changes tend to vary the gap in the rail at the joint. But the tread-block is apt to be only partly effective, since wheels with hollow treads will ride on the block, while new wheels will ride on the rail instead, in either case producing a pound. Miter-joint connections, on the other hand, pound because of the inefficient vertical fastening at the end of the lift-rail. Track troubles and frequent renewal are the result.

FIG. 1. SLIDING RAIL CONNECTION FOR DRAWBRIDGES, CLOSED POSITION.

Sleeve connections are also used for making the rail joint at drawbridge. A paper by Mr. W. G. Besler, of the Central Railroad of New Jersey, before the International Railway Congress, gave the following statistics for 31 railways which have drawbridges over which trains run at high speed:

To secure and maintain proper alinement of the rails, 17 roads use a sliding latch or rail sleeve; 9 use mitered rails and guide shoes; two use a guide trough; and one uses a special arrangement of cams.

To secure and maintain proper surface of the rails, the roads using the sliding latch or sleeve depend upon it; those using mitered joints and guide shoes, where the drawings show, use a depending lock rod which is locked by a plunger; the two roads using troughs lock the rail in the same manner as in the case of the mitered joint; and the one road by means of its special arrangement of cams, as above.

With the sleeve, lift rails are not need[ed] and the gap in the rail then is made wide enou[gh] ins on the Erie, whose sleeve-joint Mr. Besle[r] ows by drawing) to enable the bridge to c[lose] the abutment. A tread-block must, of co[urse] be used, and this is subject to the disadv[an]ges already mentioned. Also, it is difficult t[o a]void vertical play of the rail ends.

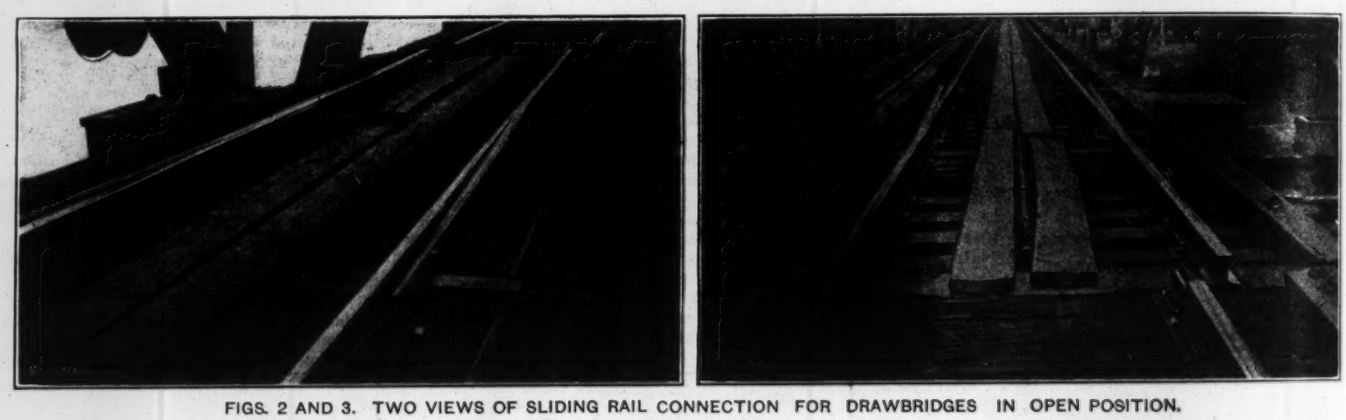
A new form of drawbridge rail connect[ion] has been developed on the Nashville, Chat[tano]oga & St. Louis Ry., with a view to overcomi[ng] weak features of lift-rail and sleeve arrangeme[nts] and securing a close joint in the rail under a[ll] conditions of temperature. Its fundamental i[dea] is to substitute longitudinal movement of th[e] rail for the lifting movement, and thereby gain a close butting contact of the rail ends und[er] all conditions, so as to render a tread-block unnecessary. The longitudinal movement, of course, secures also the guiding action of a sleeve or pocket connection just as in the ordinary sleeve connection. The rail is made movable by inserting a switch point in the bridge rail a short distance from the end of the span. The point rail faces toward the lock connection and is fixed in position, while the main or stock rail is made movable longitudinally. When this movable section is slid forward into close contact with the abutment rail the track is as smooth as that across an ordinary switch.

The action of this device is well illustrated by the half-tone views, Figs. 1 to 3 herewith, one of which shows the rail connection closed while two show the rails open. The construction is more fully exhibited by the drawing, Fig. 4.

The actual joint of the abutting rails is made by a pair of "Continuous" joint-bars, which are bolted to the fixed rail and form a pocket to receive the end of the moving rail. The outer end of each bar, facing the switch-point, is tapered by cutting away metal on the inside, thereby giving the pocket an enlarged opening which receives the sliding rail and guides it accurately to place.

The sliding rail is moved by a pitman pinned to a crank on a transverse operating shaft. The machinery in general may be identical with that of lift-rail or sleeve arrangements, and evidently either of these can easily be converted to suit the sliding-rail arrangement.

As a lock connection for the signals, a movable heel-block is provided behind the rear end of the sliding rail, as shown in the drawing, Fig. 4. This block moves in slides transverse to the track, and when the moving rail is shoved forward to place



FIGS. 2 AND 3. TWO VIEWS OF SLIDING RAIL CONNECTION FOR DRAWBRIDGES IN OPEN POSITION.

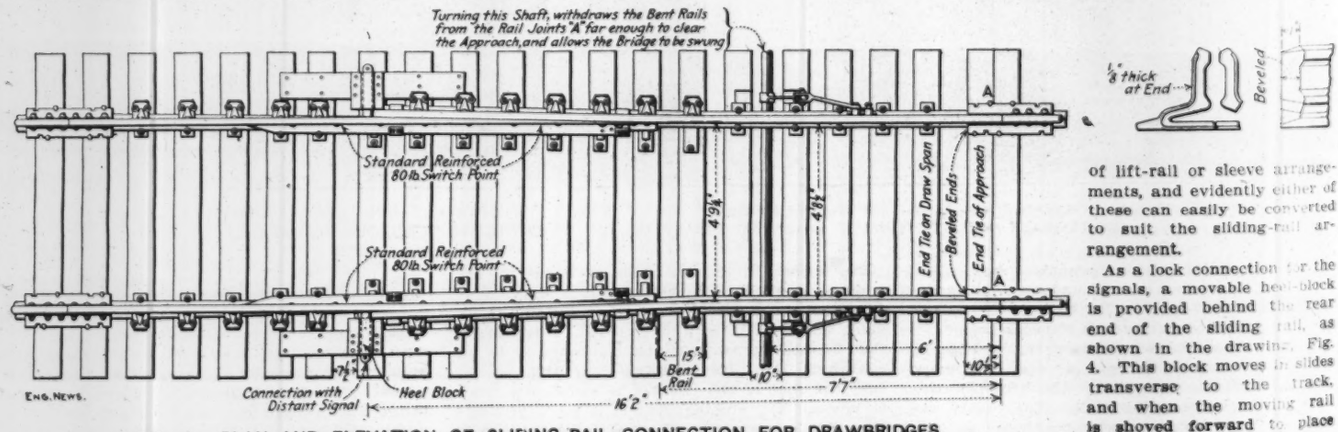


FIG. 4. PLAN AND ELEVATION OF SLIDING RAIL CONNECTION FOR DRAWBRIDGES.

the block is pushed in and prevents its return. This block is either directly connected with the distant-signal pipe-line, or operated by a lever which locks the distant signal in the machine. In any case its effect is to lock the signal at danger until the rail is slid forward, and (in opening the rail connection) to require a clear signal to be set at danger before the rail can be drawn back. The block also serves to hold the movable rail in place against all longitudinal forces exerted by braking or tractive effort of trains and thus it relieves the operating pitman from strains due to these causes.

The sliding-rail drawbridge joint was originally suggested by the use of switch-points on drawbridges to provide for the expansion and contraction of the rails and avoid trouble from fouling of rails at the lift-rail joint. One of the bridge foremen of the Nashville, Chattanooga & St. Louis Ry., Mr. W. A. King, conceived the idea that the same switch-point could be utilized for making and breaking the rail connection, by moving the rail longitudinally. The idea was taken up by the Chief Engineer, Mr. Hunter McDonald, and the Engineer of Design, Mr. J. L. Albers, who worked out therefrom the design as shown by the drawing and views. The device has since been patented (U. S. Pat. 955,809, April 19, 1910).

In working out the apparatus, the first design was based on making the point-rail the movable element. Afterward it was found better to make the stock-rail movable and fix the point-rail, which is the arrangement illustrated. The heel-block for locking the signals and furnishing a positive abutment for the sliding rail was also a later addition, which suggested itself when an engine was flagged on the draw, stopped with its drivers on the movable rail, and, upon backing to take up the slack of the train, slid both movable rails six inches and broke the attached signal lock levers.

This new drawbridge rail-connection has been in service on the Nashville, Chattanooga & St. Louis Ry. at two of its drawbridges (Bridgeport, Ala., and Johnsonville, Tenn., both over the Tennessee River) for more than two years. The service has been entirely satisfactory. With lift-rails, whether square or mitered, pounding of the track at the ends of the spans could not be prevented, but the new device has eliminated it.

Formerly the pounding of the old sleeve connections gave rise to continued trouble with the signal connections, which, being close to the rail joint, were disturbed by the pounding, so that complaints about their adjustment were constantly coming in. No such complaints have been received since the new form of connection was installed, Mr. Albers states. He also finds from examination of the track that the switch-point and rail are wearing uniformly with the adjacent rail, and will not need renewal until all rail is changed. Moreover, renewal will require only stock material carried by the tracklaying gang.

Rail Wear on Electric Railways.

Rail wear on electric railways might be expected to show a rather different character from that on steam railways, owing to the method of application of the power and to the position of the motors in relation to the wheels and rails. We do not know that any special observations have been made in this direction, but the subject was touched upon in the discussion on electric traction at the recent joint meeting (in England) of the British and American societies of mechanical engineers. Mr. Sidney Stone (of the British society) expressed the opinion that excessive rail wear on lines of this class had been well established, more particularly in regard to lines which are operated on the multiple-unit system. In his opinion a motor truck (due to the action of the motor) has a tendency to bear against one rail until the flange resistance is sufficient to throw it over to the other rail. On reaching a grade or curve also, the additional resistance checks the first car, while those behind (propelled by their motors and not affected by this resistance) push forward upon the head cars and tend to cause a buckling of the train and to cause the trucks to bear hard against one rail. In starting, also, the rear cars may crowd forward, as can be seen by noting the movements of the cars and drawbars.

As an example, Mr. Stone stated that on the District Ry., of the London underground system, he had noted irregular rail wear since the introduction of electric traction, and had remarked bright spots on the rails about 40 ft. apart, indicating that the trucks swung from side to side. On this line the longer trains have three motor cars, separated by non-motor cars. He stated that on the City & South London Ry (a "tube" underground line), where electric locomotives are used, the wear is not so marked. On the other hand, we may note (from personal observation made a few years ago) that on parts of this latter line there is a very peculiar kind of rail wear or rail corrugation. The rails showed a continuous series of distinct lateral or transverse lines of wear, slightly diagonal to the center line, a few inches apart. At that time there was considerable discussion as to the phenomenon of rail corrugation, but no satisfactory conclusion or explanation seems to have been produced.

With a steam train, the motive power is applied as a direct pull concentrated on the front drawbar. In the event of shutting off steam or encountering the resistance due to a sharp curve or steep grade there may be a momentary check to the locomotive and a consequent tendency of the cars to crowd forward. In this case, however, the tendency is due only to the momentum of the cars, while in the case of an electric multiple-unit train there is the direct power of the rear motors tending to push the cars forward against the resistance. On interurban electric railways in this country where the cars are operated in trains, the lateral swaying movements of the cars in relation to each other are usually much greater than in a steam train; and this irregular motion may be due in part to the action of the trucks upon the rails, as caused by the direct application of power to the axles instead of its concentration at the drawbar. In return, the movement of the car body, when of high degree, is quite likely to disturb the steady riding of the trucks. The final result will be, no doubt, an excessive and irregular wear of both rails and wheels. To prevent this action, Mr. Stone suggested that the head motor car should have a greater proportion of the power, so as to maintain uniformly a tension on the drawbars of the train. A system of this kind has in fact been devised by him, but whether it is practicable or necessary is not yet evident.

A REAR COLLISION NEAR DURAND, MICH., on the Grand Trunk Ry., Aug. 24, killed eight persons and injured as many others. The two trains, Nos. 4 and 14, were sections of the Montreal and Boston express from Chicago. Trouble with the airbrakes caused the engineer of the first section, No. 14, to bring his train to a stop, two or three miles east of Durand, at about 10.30 p. m. One of the trainmen was sent back to flag the second section, but his efforts were either inadequate or unheeded, and the locomotive of No. 4 crashed into No. 14's rear sleeper, in which were 19 passengers.

FOREST FIRES IN THE NORTHWEST were considerably checked, according to reports of Aug. 24, by heavy rainfalls on that date. The total loss of life in the fires this fall in Idaho, Montana and Washington is estimated at more than 200. The majority of the dead consists of Forest Service employees. Reports of Aug. 25 stated that extensive fires were raging in Oregon in the Bull Run drainage area, from which is derived the city water-supply of Portland.

Mr. Gifford Pinchot, formerly at the head of the U. S. Forest Service, has issued a statement attributing the heavy loss of property and life to the inadequate number and equipment of the forest rangers, due to insufficient Congressional appropriations. Mr. Pinchot states that forest fires are preventable. If a forest is equipped with roads, trails, telephone lines and a reasonable number of men for patrol there is no more likelihood that great fires will be able to get started than there is that great conflagrations like the Chicago fire will get started in a city with a modern fire department.

FIRE LOSSES IN PRAGUE, BOHEMIA, during the past three years have been only $20,000 annually, in round numbers, according to a report from U. S. Consul Jos. L. Brittain. During the past 15 years, Mr. Brittain states, not a life has been lost in Prague in consequence of fire. The city named, it should be added, has a population of about 500,000. Few of the buildings in Prague are more than five stories high and nearly every building is constructed of brick, laid in cement. An essentially fireproof construction is used throughout buildings, with practically no exposed woodwork, except that "attics usually have exposed wooden floors and rafters, but no one is permitted to sleep in the attic." The Fire Department force of Prague includes 169 men.

NEW YORK CITY FIRE DEPARTMENT.—The report of Mr. Rhinelander Waldo, Fire Commissioner, as summarized in the City Record of Aug. 27, shows that on Dec. 31, 1909, 4,350 officers and men constituted the force. There were 172 engine companies, 73 hook-and-ladder companies and 8 hose companies; a total of 253. There are also four water towers, three searchlight engines and ten fire boats. The gradual change of personnel is reflected in the 230 appointments to the uniformed force made in 1909. The number of alarms responded to was 14,800, or 500 more than in 1908. The total number of fires was 8,132 with a total loss of $5,388,390, or $662.61 per fire. This shows a decrease of 510 fires from 1908, accompanied with a decrease in total loss of $809,503, or of $54.57 average loss per fire.

A STREET RAILWAY VALUATION of the property of the Chicago Consolidated Traction Co. has been made by Mr. Bion J. Arnold and Mr. Geo. W. Weston (constituting the Traction Valuation Commission) in connection with an ordinance to permit the acquisition of this property by the Chicago Railways Co. The rights of the former company have nearly all expired. In the valuation, all franchise values have been excluded, and the physical property has been appraised at its value for rehabilitation purposes. The Chicago Railways Co. is required by the ordinance to reconstruct 29 miles of single track by Jan. 28, 1911, and to put in service 215 double-truck cars and provide additional car house facilities. The track is to be of 91-lb. T-girder rails, with nose bricks or granite blocks to form the flangeway for the wheels. The valuation is as follows:

Track (128 miles)	$1,177,277
Electric power distribution	728,150
Rolling stock (344 cars)	204,875
Power plant equipment	438,781
Tools, supplies and furniture	75,000
Buildings	278,688
Real estate	88,439
Paving	459,088
Total	$3,450,904
Percentages allowed by ordinances	517,636
Total	$3,968,540

NEW KINGWOOD TUNNEL, B. & O. RY.—The Baltimore & Ohio R. R. Co. is about to construct a new double-track tunnel to supplement its old single-track Kingwood Tunnel on the main line from Baltimore to Parkersburg a short distance west of the Maryland state line. The tunnel is at the summit of the grade between Grafton and Rowlesburg, W. Va. The existing tunnel is 4,100 ft. long. It was constructed between the years 1849 and 1852, by forces under the direction of Chief Engineer Latrobe of the Baltimore & Ohio R. R. The new tunnel will be parallel to the old, about 80 ft. to the south, but on a lower-grade plane. The line will be revised for some 3 miles east, in conjunction with the new tunnel, giving better operating conditions. The new tunnel will be 4,250 ft. long, double-track, with tracks 14 ft. apart c. to c. After it is completed the old tunnel will be used for a westbound track only, and since the grade is downhill in westerly direction it should be free from smoke. Construction will be under the direction of Mr. A. W. Thompson, Chief Engineer of the B. & O. R. R. The contract has been let to Bennett & Talbott, of Greensburg, Pa.

FOUR SIGNAL APPRENTICES have been appointed by the Pennsylvania R. R. as a part of a comprehensive plan for the maintenance and operation of signals. These men, and others who may be appointed from time to time, are college graduates who will serve a three years' course. The first year will be spent on mechanical work with repair and construction gangs, the second year in the office of the Supervisor of Signals, and the third year on outside work on electric and electro-pneumatic appliances. They will report to the Supervisor of Signals while taking this course. The first advancement for apprentices will be to the position of Assistant Signal Inspector in the Signal Engineer's Office and after this to the positions of Assistant Supervisor of Signals, Supervisor of Signals, Inspector, Assistant Signal Engineer and Signal Engineer. In addition the different divisions of the lines east of Pittsburg have started signal schools where experienced signalmen give instruction to the division signal employees in regard to the proper operation and maintenance of the different signal and interlocking appliances. The need for this step may be found in the tripling of interlocking move-

ments in the last six years; at present 12,408 signals are in service on 3,385 miles of road and 20,725 signal functions are controlled by 8,792 levers.

THE LEANING TOWER OF PISA is causing the authorities of Pisa considerable worry. Ever since the Campanile in Venice collapsed some years ago suspicion has been directed at the Pisan tower which is about contemporaneous with the one at Venice. It will be remembered that the Campanile had an inclination of about 1 in 125 or about 30 ins. in its 321 ft. height. The tower at Pisa, however, is 15.4 ft. out of plumb in its 177 ft. height, about 1 in 12. There is a record that several Englishmen measured its inclination in 1829 and found it to be 14.4 ft. out of plumb. If this old record is authentic there has been an additional shift of 1 ft. horizontal in the top of the tower since that time. Recent investigations of the foundations show that instead of having a solid footing, the tower has a ring footing the interior diameter of which is exactly equal to the interior diameter of the tower, so that there is no stiffening base to add to the stability. As yet no announcement is made as to possible strengthening operations, but it is thought probable that some such action will be taken.

THE VIDLER MINING TUNNEL under the Argentine pass (near Gray's Peak), in Colorado, is again under construction, with the purpose of giving an outlet for the Montezuma and Leadville mining districts. The work is being done by the Argentine Construction Co. According to the "Engineering and Mining Journal," it was started originally with the expectation of opening up large bodies of ore, but an engineer's inspection (made after a large investment had been sunk) showed that no ore of commercial value had been opened. The tunnel is about 8 × 7 ft., and has been driven for 4,048 ft. at the east side and 710 ft. on the west side, leaving 2,778 ft. yet to be driven. It has been reported at various times that it would be enlarged to serve as a railway tunnel, but as it is some 11,000 ft. above sea level it is not well adapted for such use, while the cost would be considerable. It is suggested, however, that its present size would enable ore to be brought through from the Montezuma and other mining districts by a direct route, reducing the cost of transportation.

CONVICT LABOR FOR STATE ROAD CONSTRUCTION in Colorado is being carried on in a novel manner under the direction of Mr. Thomas J. Tynan, Warden of the State Penitentiary, Canon City. After a period of careful watching subsequent to arrival at the penitentiary, promising convicts are sent out into one of three camps in the mountains, each man, according to an interesting article by Mr. Eugene L. Bertrand in "The World's Work" for September, being "put on his honor not to try to escape." An unarmed officer superintends the convict road construction work. At night a "convict selected for the purpose, patrols the tented camp more to keep marauders out than to keep the convicts in. He carries a rifle, the only one in the camp." It is posible for each of these convicts to cancel ten days of their sentence period for every 30 days of road service. This is in addition to the usual time allowed for good behavior. The men are allowed to talk to each other while at work and to engage in sports, fishing, etc., after work until 9 p. m. Better food and clothing are provided for the convicts on road work than for those left in prison. Each camp is provided with a corrugated-iron both-house, supplied with warm water and bathtubs. The convict labor is being used to build a highway extending

from Raton, N. M., on the south to Cheyenne, Wyo., on the north, skirting the eastern foothills of the Rockies all the way up and passing through Pueblo, Colorado Springs, and Denver. From Pueblo a road will diverge to the west and north across four mountain ranges, extending as far as Grand Junction, near the Utah line.

An average of 90, 40 and 30 men are at work in the vicinity of each one of the three camps. In addition to the road work, a number of convicts are employed on a farm of several hundred acres near the penitentiary, and other convicts are engaged on various ranches. Altogether, some 360 men, or about half of the prison population, are engaged in outdoor work.

Personals.

Mr. W. S. Kinnear, M. Am. Soc. C. E., has resigned his position as Assistant General Manager of the Michigan Central R. R. to become President of the Kansas City Terminal Ry.

Mr. Wm. J. Ball has been appointed Mechanical Engineer of the Crawford Locomotive & Car Co., of Streator, Ill. He was formerly with the Bettendorf Axle Co. and the Pullman Car Co.

Mr. F. W. Campbell has been made Manager of the sales office of the Westinghouse Electric & Manufacturing Co., at Houston, Tex., to succeed Mr. Allen Ashley. Mr. Campbell is a graduate of the Case School of Applied Science, class of 1905.

Mr. Nicholas von Brauley and Mr. Simon Elborowibetz, engineers of the Russian railway system, were in Philadelphia Aug. 22 and 23 examining railway yards and locomotive works. They are engaged upon a world's tour of railway inspection.

Mr. E. A. Gould, General Superintendent of the Cincinnati, Hamilton & Dayton Ry., has been made Assistant to the President. He has been succeeded in the general superintendency by Mr. Frank H. Alfred, M. Am. Soc. C. E., formerly Chief Engineer and Assistant to the President.

Major Thomas H. Rees, U. S. Corps of Engineers, stationed at Chicago, has been assigned to duty at the War College at Washington. The duties of the Chicago office will be assumed by Major Charles S. Bromwell, of the Milwaukee office, until such time as a successor to Major Rees is appointed.

Mr. Paul Hansen, Assoc. M. Am. Soc. C. E., for several years connected with the Ohio State Board of Health as Assistant Engineer and for the past year serving as Acting Chief Engineer, has been appointed State Sanitary Engineer of Kentucky, to take effect on Sept. 1. The appointment was made by the State Board of Health of Kentucky, which has also appointed Mr. Hansen a member of the Ohio River Sanitary Commission.

Mr. J. H. Miner, Assoc. M. Am. Soc. C. E., of Phillipston, Mass., Assistant Engineer, U. S. Reclamation Service, in charge of work on the Gunnison Tunnel, Uncompahgre Valley irrigation project, Colorado, has been appointed Project Engineer of the Grand Valley project in the same state, to succeed Mr. E. E. Sands, who recently resigned. Mr. Miner is a graduate of Cornell University, class of 1900. He has been an assistant engineer on the Uncompahgre Valley project since May, 1904.

Mr. Frank C. Magruder, of Webb City, Mo., Assistant Engineer, U. S. Reclamation Service, in charge of operation and maintenance of the Belle Fourche irrigation project in South Dakota, has been appointed Project Engineer to succeed Mr. R. F. Walter, M. Am. Soc. C. E., who is now acting as Supervising Engineer in charge of the central division of the Reclamation Service. Mr. Magruder is a graduate of the University of Missouri, and has been engaged in engineering work on the Belle Fourche project in various capacities since 1903.

Appointments of officials for the newly named Chesapeake & Ohio Ry. of Indiana (formerly the Chicago, Cincinnati & Louisville R. R.) have been announced as follows: Mr. M. S. McDonald, formerly General Claim Agent of the Chesapeake & Ohio Ry., has been appointed Division Superintendent, with headquarters at Peru, Ind. Mr. R. P. Dalton, formerly General Superintendent of the Chicago, Cincinnati & Louisville, has been appointed Superintendent of Terminals and General Agent in charge of the Chicago terminal. The jurisdiction of the following officials of the Chesapeake & Ohio has been extended over the Chesapeake & Ohio of Indiana: Mr. J. P. Stevens, General Superintendent; Mr. L. B. Allen, Engineer of Maintenance of Way; Mr. W. T. Smith, Superintendent of Motive Power; Mr. C. C. Walker, General Superintendent of Transportation; Mr. J. F. Walsh, General Superintendent of Motive Power; Mr. T. M. Ramsdell, Master Car Builder; Mr. J. S. Stevens, Superintendent of Telegraph; Mr. Charles Stephens, Signal Engineer; Mr. J. M. Staten, General Inspector of Bridges.

Obituary.

Lewis Van Duyne, a civil engineer and contractor of Boonton, N. J., died Aug. 23 at his home in that place aged 55 years.

Lucius A. Cole, of East Orange, N. J., President of the National Lead Co. since 1896, died Aug. 25 at Carlsbad, Germany, where he had gone for his health.

Charles Talbot Porter, Hon. M. Am. Soc. M. E., co-inventor with John F. Allen of the Porter-Allen high-speed engine, died Aug. 28 at Montclair, N. J. A fuller account of his life and achievements will be published in our next week's issue.

James Roosevelt Shanley, a contractor, of New York City, died Aug. 25 aged about 55 years. He was President of Shanley-Morrisey, Incorporated, contractors, the American Automatic Switch Co., and the Royal Machine Co.; Treasurer of B. M. Shanley's Sons and the Concrete Building Block Co.; and Secretary of the B. M. & J. F. Shanley Co. and the Stewart-Kerbaugh-Shanley Co.

John J. McVean, M. Am. Soc. C. E., died Aug. 21 at his home in Grand Rapids, Mich., aged 60 years. Mr. McVean was born near Batavia, N. Y., and first entered upon engineering work as a rodman on railway construction in western New York. He went to Michigan in 1878 as Locating Engineer for the Detroit, Lansing & Northern R. R. (now a part of the Pere Marquette R. R.) became Chief Engineer of that road in 1882 and in 1889 became also Chief Engineer of the Chicago & West Michigan R. R. He held this position until 1899, when he was obliged by ill health to give up active service. Partially recovering his health, in 1905 he opened an office in Grand Rapids as a consulting engineer. He was a member of the Western Society of Engineers and of the American Railway Engineering and Maintenance of Way Association. In 1898-1900, he was a director of the American Society of Civil Engineers.

Engineering Societies.

COMING MEETINGS.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 5-9. Annual meeting at Milwaukee, Wis. Secy., W. C. Woodward, Washington, D. C.

NATIONAL CONSERVATION CONGRESS.
Sept. 5-9. Second annual meeting at St. Paul, Minn. Secy., Thomas R. Shipp, St. Paul, Minn.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 6-8. Annual meeting at Thousand Islands, N. Y. Asst. Secy., Walter Neumuller, 55 Duane St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 6-9. Annual convention at Rochester, N. Y. Secy., Frank P. Foster, Corning, N. Y.

MICHIGAN GAS ASSOCIATION.
Sept. 8-12. Annual meeting on board steamer sailing from Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 13-16. Annual convention at St. Louis, Mo. Secy., A. P. Dane, Reading, Mass.

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION.
Sept. 13-16. Annual convention at Chicago, Ill. Secy., Walter E. Emery, Chief Engineer, Peoria & Pekin Union Ry., Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 21-23. Annual convention at Colorado Springs. Secy., J. C. Lawler, P. O. Box 938, Colorado Springs.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 21-23. Annual convention at Rochester, N. Y. Secy., Willard Kent, Narragansett Pier, R. I.

NATIONAL IRRIGATION CONGRESS.
Sept. 26-30. Annual meeting at Pueblo, Colo. Secy., Arthur Hooker, Pueblo, Colo.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 10-14. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 11-14. Annual convention at Erie, Pa. Secy., A. P. Folwell, 239 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 11-13. Annual meeting at Richmond, Va. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 13-15. Annual meeting at Chicago, Ill. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 18-20. Annual convention at Denver, Colo. Secy., C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 19-21. Annual meeting at New York City. Secy., A. B. Beadle, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 21-Nov. 15. Canal Zone meeting. Secy., R. W. Raymond, 29 West 39th St., New York City.

ILLUMINATING ENGINEERING SOCIETY.
Oct. 24. Annual convention at Baltimore, Md. Secy., P. S. Millar, 29 West 39th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.—The place of meeting for the 20th annual convention, Oct. 18-20, has been changed from Fort Worth, Tex, to Denver, Colo.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—The annual convention will be held at the coliseum at St. Louis, Mo., Sept. 27-29. Papers will be delivered on "Dam Construction for City Water Supplies," by J. B. Goldsborough and Ed. Wegmann, both of New York City, and on "Work Preliminary to Street Paving and Road Work," by George C. Warren, of Boston, Mass. The secretary is Mr. D. J. Hauer, 13 Park Row, New York City.

VERMONT ELECTRICAL ASSOCIATION.—The annual meeting of the Vermont Electrical Association will be held at Brandon, Vt., Sept. 28 and 29. A feature of the meeting will be the commemoration of the work of Thomas Davenport who, in 1835, made an electric motor and built the first model of an electric car, which he operated by current from a primary battery. A tablet will be unveiled at the old Davenport shop at a joint meeting with the Vermont Historical Society and the state branch of the National Electric Light Association.

SAN FRANCISCO ASSOCIATION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting of Aug. 19, a discussion by Luther Wagoner of Mr. J. A. Griffin's paper on "The Ultimate Load on Pile Foundations" was read by the secretary. Mr. Charles G. Hyde, then presented a long illustrated paper, entitled "A Study of the Present Water Supply of the City of Sacramento, and a Proposed Means of Improvement." This paper presented a brief history of Sacramento water supplies and a detailed explanation and description of the proposed improvements.